

# Vegetable Crops

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## Vegetable Pests

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In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making any pesticide applications.

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Visit the *PNW Insect Management Handbook* website, <http://pnwhandbooks.org/insect> to find pictures, print-on-demand information and directions to other useful website links.

Only pesticides with current federal or state registrations during the annual handbook review period are listed. Registrations change every day. Use the handbook as a first reference only. Always check the current label before purchase and application. Not all registered materials are listed in the handbook. Omissions may occur accidentally or intentionally, such as when a specific use, site, crop, pest, or restriction is in question.

Suggestions for use are based on current labels and the assumption that when a pesticide is used in the prescribed manner (exact dosage, method of application, and specified time interval between application and harvest), the raw agricultural product will not bear illegal residues. However, satisfaction with the level of pest control will vary a great deal. This is particularly true of the new or well-established “softer” insecticides, where excellent coverage and multiple applications sometimes are required to achieve acceptable pest control.

Frequent reference is made to the statement, “Do not feed crop or crop residues to poultry, dairy, or meat animals.” It is known that when forage which bears residues of certain pesticides is fed to dairy or meat animals, there is a possibility that residues of these pesticides will appear in milk and animal tissue.

The pesticides suggested in the Vegetable Section of the handbook do not necessarily apply to vegetables grown in greenhouses nor for seed.

**Note:** Products are listed in alphabetical order and *not* in order of preference or superiority of pest control.

## Vegetable crop pests—Aphid

**Biology and life history** Most species of aphids have similar life cycles. Aphid females give birth to live offspring all year without mating. When vegetable crops are not available, aphids live on a wide variety of weed hosts. In summer and fall, aphids may produce winged females and, later, winged males. They mate and produce eggs for overwintering, especially in colder climates. Otherwise, adult aphids overwinter on crops, weeds, or trees. There may be as few as two generations (the green peach aphid) or as many as 16 generations each year, depending on the species and climate.

**Pest description and crop damage** The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Infestations may result in wilting. The melon aphid is variable in color but is often light green mottled with dark green. Unlike other aphids, it is able to tolerate hot weather. The potato aphid has both a pink and green form. It is a larger aphid. High potato aphid populations can distort leaves and stems, stunt plants, and cause necrotic spots on leaves. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit.

In general, aphids damage plants by contaminating the harvested fruit; sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases such as alfalfa mosaic, tomato yellow top, and zucchini yellow mosaic (a large number of viruses are spread by aphids). Infestations frequently are localized, with heavily infested leaves curled downward.

## Vegetable crop pests—Armyworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

**Pest description and crop damage** Beet armyworm moths have a wingspan less than 1.25 inches, and are mottled gray and brown, with irregular banding and a light colored, bean-shaped spot. Eggs are pale green to pink, ridged, and deposited in a mass which is covered with a white cottony material. The tiny, newly hatched larvae feed in colonies. The larvae are about 1.25 inches long when full grown and are mottled olive green to almost black.

Bertha armyworm adult moths have a wingspan up to 1.5 inches long and are predominantly gray with patches of brown, black, olive, and white. Eggs are white when laid, turning black just before hatching. They are laid in clusters of 50 to 100. Mature larvae are about 1.25 inches long and are variable in color. Young larvae, when disturbed, quickly spin down from the plant on a strand of silk. The pupa is 0.75 inch long, reddish brown, with a pair of unusually long spines with curved tips on the rear (posterior) end.

Moths of the western yellowstriped armyworm have gray or brown wings with slate or buff colored markings, and have a wingspan of about 1.5 inches. Eggs are similar to those of the beet armyworm, though the egg masses are larger and covered by a gray cottony material. The larvae grow to about 1.5 inches and are variable in color, with pronounced black triangular markings along each side and a prominent yellowish stripe and several narrow bright ones below. The reddish brown pupa, about 0.75 inch long, is in a cell with a thin lining of silk.

Armyworm larvae feed in colonies shortly after hatching and skeletonize leaves. As they grow larger, they tend to disperse and consume irregular patches of foliage or entire leaves.

**Biology and life history** Beet armyworm eggs are laid on leaves of crops or weeds in clumps or masses that the female covers with white hairlike scales, giving the egg masses a cottony appearance. The tiny first instar larvae feed in groups near the egg mass. They skeletonize the leaves and may completely consume small leaves on seedlings. As they grow, they disperse and move towards the center of the plant. The larvae are quite mobile and may attack several plants.

The Bertha armyworm overwinters as a pupa. Moths emerge in June and July to mate and lay eggs. Eggs hatch in 3 to 5 days, and larvae feed for 5 to 6 weeks before pupating in the soil in early September. There are two generations each year. Larvae may be found in the soil resting in the shade. There is high mortality of larvae. Larvae reach maturity in 2 to 3 weeks in warm weather.

The western yellowstriped armyworm overwinters in the soil as a pupa. Moths emerge in March and April and lay eggs in masses on foliage. Larvae feed on the foliage for 6 to 8 weeks during May through early July, then pupate in the soil. Larvae frequently feed on the terminal leaves and buds. Adults from the second generation emerge in mid-August and early September and lay eggs. The larvae that hatch from these eggs feed on plant foliage during late September and early October before entering the pupal stage to overwinter. There are two overlapping generations each year.

## Vegetable crop pests—Cabbage maggot

*Delia brassicae*

**Pest description and crop damage** Larvae are small, legless white maggots usually less than about 0.31 inch when full grown. Their head end is pointed, and the rear is blunt with a dozen short, pointed, fleshy processes arranged in a circle around two brown, buttonlike spiracles. They are found feeding on feeder roots or boring into the taproot.

Adults are dark gray flies about half the size of the common housefly. They lay their eggs in cracks in the soil near plant stems, and hatching larvae burrow beneath the soil surface to invade the roots. After feeding 3 to 5 weeks, larvae pupate in roots or surrounding soil. Adults may emerge from pupae within 2 to 3 weeks, or the pest may overwinter as pupae when conditions are unfavorable for development. There are at least two generations in cool, moist climates along the coast.

Cabbage maggots damage and destroy root systems of all cole crops, riddling roots with tunnels when infestations are heavy. Tunnels provide entry for pathogens that cause blackleg and bacterial soft rot. Youngest plants are most susceptible. Healthy plants attacked after they are well established usually can tolerate moderate infestations. Cauliflower and Brussels sprouts may be more susceptible than hybrid cultivars of broccoli, and crops planted in winter and spring suffer more damage than summer planted crops.

**Biology and life history** Cabbage maggots overwinter as pupae in the soil or in the trash. Adults emerge in the spring, mate, and females lay eggs at the base of host plants or in cracks in the soil near the plant. The eggs hatch in 4 to 10 days into tiny maggots which immediately work down along the stem. They mature in about 3 weeks, leave the stems, and pupate in the soil near the soil surface. Flies emerge in about 2 weeks and lay eggs for another generation. These larvae feed in stems or roots, mature, and pupate to form the overwintering stage.

## Vegetable crop pests—Carrot rust fly

*Psila rosae*

**Pest description and crop damage** Mature larvae are dusty, straw-color, maggot-like, and from 0.12 to 0.25 inch long. Worms burrow into and through roots. Burrows often are filled with rust-red frass. Carrot rust fly adults are shiny black or dark brown with yellowish legs, a brownish head, and iridescent wings. They are about 0.25 inch long with a 0.5-inch wingspan. Eggs are tiny and white. The legless larvae initially are colorless but become creamy white as they develop through three instars (growth stages). Pupae develop inside a yellowish-brown skin about 0.2 inch long.

The carrot rust fly is a major pest of carrots, but it also may infest parsnips, turnips, parsley, and celery. Hemlock, a related weed species, is known to

be a host plant also. Damage is caused by larvae burrowing into the taproot. Young plants wilt and may die, but more often the plants are stunted temporarily and the carrots become bulbous, forked, and unmarketable. In addition, fungi and bacteria may invade the damaged tissue and cause severe rot at the crowns of the plants. On parsnips and celery, larvae more commonly are found nearer the crown and may burrow into the base of leaf stalks.

**Biology and life history** The carrot rust fly overwinters as a larva in roots left in the field. These larvae pupate in February and March, and adults begin emerging in mid-April and continue until mid-June. Adults prefer to shelter in hedges. Eggs are laid on the soil surface or slightly below the surface at the base of plants. Larvae are present from June to mid-July and mature in about 30 days. Larvae feed on the taproot or side roots of the host plant. When mature, they leave the root and pupate nearby in the soil.

The summer brood of flies emerges about mid-July, and larvae are present during August. Pupae from this brood can be found in mid August to late September. The fall brood of flies emerges from late September to mid-October. Larvae enter roots from early October to early November. Larvae from this last brood overwinter in roots in the field.

## Vegetable crop pests—Colorado potato beetle

*Leptinotarsa decemlineata*

**Pest description and crop damage** Adults are oval, strongly convex beetles with hard wing covers marked with black and yellow stripes running lengthwise along their back. They are about 0.5 inch long and 0.25 inch wide. Larvae are very plump, dark red when young, but become orange as they near maturity. They have two conspicuous rows of black spots along the sides of the body and are about the same size as the adults. Colorado potato beetles feed almost exclusively on plants of the Solanaceae family, i.e., potato, tomato, eggplant, pepper. Adults and larvae can cause great damage to potato foliage.

**Biology and life history** Colorado potato beetle overwinters as an adult in the soil and emerges in late April and May to lay eggs. Adults lay eggs in masses of 10 to 30 on the undersides of leaves. Eggs hatch in 7 to 10 days, and the larvae begin feeding on the undersides of leaves. Larvae mature in 2 to 3 weeks, drop to the soil, and enter cracks to pupate. Adults emerge in 5 to 10 days, mate, and deposit eggs as before. Larvae of the second generation mature and pupate in the soil. Adults from this generation form the overwintering stage in the soil. A generation can be completed in 30 days.

## Vegetable crop pests—Corn earworm

*Helicoverpa zea*

**Pest description and crop damage** Corn earworm moths are about 0.75 inch long, robust, with a wingspan of 1 to 1.5 inches, and range from olive green to tan to dark reddish brown. Eggs are pale green at first, turning yellowish and finally gray. Young larvae are greenish with black heads and conspicuous black hairs on the body. Fully developed worms are about 1.5 inches long and range in color from pale green or pinkish to brown. Pupae are about 0.75 inch long and mahogany brown. They usually are 2 to 4 inches deep in the soil.

Corn earworm is a major pest of sweet corn occurring at significant levels in most years, though it may not be treated for in commercial sweet corn for processing in some areas. The tip of the ear is cut off during the early stages of processing. The corn earworm may be present throughout the year but is most abundant during August and September. Larvae feed on leaves, tassels, the whorl, and within ears, but the ears are the preferred sites for corn earworm attack. Ear damage is characterized by extensive excrement at the ear tip.

Young larvae feed on corn silks, clipping them off. Shortly thereafter, they feed their way into the ear where they remain, feeding in the tip area until they exit to pupate in the soil. First generation larvae may feed as “budworms,” damaging leaf whorls and newly forming ears (in Columbia Basin area).

**Biology and life history** The corn earworm overwinters as a pupa in the soil except in some areas in the north, where it is unable to survive the winter. Adults emerge in late May and June and begin laying eggs on suitable hosts. Egg laying occurs throughout the sweet corn growing year. Corn earworm moths are most active during evening and night.

Although eggs are deposited on the foliage, fresh corn silk is the favorite site for egg deposition. Female moths lay their eggs singly. Eggs are white at first but develop a dark red or brown ring within 24 hr. Eggs hatch in 5 to 7 days. Larvae feed for 2 to 3 weeks before pupating in the soil. Adults emerge in about 2 weeks and lay eggs on corn silk or developing fruits. Moths move northward and establish infestations in areas where they cannot overwinter.

The summer generations overlap, resulting in a regular and gradual build-up of the corn earworm population from the beginning to the end of the year. There are two to three generations each year.

## Vegetable crop pests—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description and crop damage** The western spotted cucumber beetle is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white and about 0.62 inch long. The head and last abdominal segment are dark brown. A close relative, the western striped cucumber beetle, is yellowish and has three black lines down its back. The larvae live in the soil where they feed on roots, but adults are foliage and flower feeders.

Cucumber beetle adults eat small holes in the leaves and flowers of many crops. They are especially damaging to snap beans, causing pods to be deformed. Larvae feed on roots and bore into the base of stems of corn, peas, and many other crop plants.

**Biology and life history** Cucumber beetles overwinter as fertilized females and are active beginning in early spring. Adults lay eggs at the base of

plants. Eggs hatch in 7 to 10 days, and larvae feed in roots for about 3 weeks before pupating in the soil. Adults emerge in 2 weeks and begin feeding on pollen, plant foliage, flowers, and pods. It takes 30 to 60 days to complete a life cycle. There are two generations a year.

## Vegetable crop pests—Cutworm

### Includes

Black cutworm (*Agotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

**Pest description and crop damage** The black cutworm moth is a uniform dark brown with a lighter irregular band near the wing tips and a distinct black dash. It has a wingspan of 1.5 to 2.12 inches long. Eggs are white at first, later turning brown. Larvae are a uniform gray to nearly black, lighter underneath, ranging in size from 0.18 inch to 2 inches as they pass through up to nine instars. The pupa is dark brown and about 0.75 inch long. Most feeding is at ground level. In the Willamette Valley, black cutworm is considered to be the most damaging cutworm species to vegetable crops. The last instar does by far the most feeding, though middle instars can cut down seedlings.

Variegated cutworm moths are approximately 1 inch long with a wingspan of 1.25 to 2 inches. They vary widely in coloration. Eggs are white to dull or off-white in color, and ribbed. They generally are deposited in massed rows on crop foliage but frequently are found on weeds. Larvae are brownish gray to grayish black and up to 1.75 inches long when fully grown. Pupae are mahogany brown and about 0.75 inch long. The variegated cutworm feeds readily on a wide variety of crops and climbs into the host plant to feed. Cutworms are most active and cause the most damage during spring and early summer months.

**Biology and life history** During mild winters, the black cutworm overwinters in field debris and brush as a pupa. Otherwise, it flies in from warmer climates in late spring. The variegated cutworm overwinters in the soil or under trash as a partially mature larvae.

Larvae begin feeding in early spring and may damage seedlings. They mature in late April and May and pupate in earthen cells in the soil. Adults emerge in late May and June. Black cutworm moths scatter their eggs across the field. Variegated cutworm lays eggs in clusters on the undersides of leaves. Eggs hatch in 4 to 7 days, and larvae begin to feed on plant foliage. Larvae feed for 4 to 6 weeks, then pupate in the soil. The next generation of adults emerges in late August and lays eggs. These hatch into larvae which form the overwintering stage for the variegated cutworm. There are two generations each year.

## Vegetable crop pests—Diamondback moth

*Plutella xylostella*

**Pest description and crop damage** Diamondback larvae are smaller than most other caterpillars in cole crops, about 0.31 inch when full grown. The larval body is wider in the middle and tapers at both ends, with two legs (prolegs) on the last segment forming a distinctive V-shape at the rear end. When disturbed, the larvae wiggle frantically or rapidly attach a silken line to a leaf and drop over the edge. They feed mostly on outer or older leaves of older plants, chewing out small holes, or at the growing points of young plants. They also feed on floral stalks and flower buds. Adult moths are small, slender, and grayish brown. Male moths display three diamond-shaped markings on their back. In the Pacific Northwest, the damage from diamondback moth is not so much from feeding as from contamination by pupae. Late stage instars crawl into stems infesting harvested crops.

**Biology and life history** Cabbage is the preferred host, but it also attacks all cole family crops. The adult overwinters in trash in and around fields. Adults emerge in May and early June and lay eggs singly or in twos or threes mainly on the upper sides of leaves. The eggs are minute. They hatch in 4 to 8 days. Larvae feed mostly on the undersides of outer or older leaves of older plants, chewing out small holes, and mature in 10 to 30 days. They then spin loose white cocoons, which they attach to leaves or stems, and pupate within them. Adults emerge in 10 to 14 days. There may be two to four overlapping generations each year.

## Vegetable crop pests—European earwig

*Forficula auricularia*

**Pest description and crop damage** Earwigs are elongate, flattened, reddish brown insects about 0.75 inch long. They are identified easily by the forcepslike pincers on the end of the abdomen. They have chewing mouthparts and may be winged or wingless. Young earwigs (nymphs) are similar in appearance but are white to olive green and lack wings. They are harmless to humans or animals, though they may give a slight pinch with their forceps. They can emit a foul-smelling liquid if alarmed.

Earwigs feed primarily on decaying organic matter and are quite beneficial in that they also consume other small insects. However, they also like to chew small holes in the leaves and tender shoots of many garden flowers such as marigolds, hollyhocks, dahlias, zinnias, asters, and gladiolus. In vegetable gardens, they can be a problem on seedlings of lettuce, celery, cole crops, beets, corn, beans, carrots, and others.

**Biology and life history** Earwigs overwinter just below the soil surface as both eggs and adults. In spring, females lay 20 to 50 smooth white to cream-color eggs in the soil. The young progress through partial metamorphosis to adults in 4 to 5 nymphal stages by late summer. In fall, females may lay more eggs.

Earwigs are active at night. During the day, they hide in moist, shady places such as compost piles or beneath stones, boards, and debris. They sometimes can be found in homes, particularly in summer, but they do no damage to house or contents. They rarely fly but can move rapidly, or can be moved by lumber, cars, luggage, or other means. They are attracted to lights.

## Vegetable crop pests—Flea beetle

### Includes

*Epitrix* spp.

*Phyllotreta cruciferae*

**Pest description and crop damage** Flea beetle adults are metallic greenish brown to black in color and from 0.06 to 0.12 inch long. They derive their name from their well-developed hind legs; when disturbed, they jump like fleas. The larvae live in the soil, are slender, whitish, and about 0.25 inch long when mature. Adult beetles chew small holes in leaves, giving them a sievelike appearance. The cotyledons of emerging seedlings are especially susceptible to damage. Larvae feed on underground parts of the plant. High populations of flea beetles feeding on seedling plants can result in stand loss. Foliar damage to mature plants is not considered to be damaging economically. Flea beetles contribute to the spread of various plant diseases.

**Biology and life history** Most flea beetle species have similar life cycles. Adults overwinter in trash around field margins. They become active in late March through May. Flea beetles lay their very small eggs in May in the soil around the plant, on the leaves, or in cavities hollowed out in stems. The larvae feed on the foliage, mine the leaves, or attack the roots, depending on the species, usually from June to mid July, when pupation in the soil occurs. Adults emerge from July through early September and feed a short time before overwintering in trash around field margins. Depending on the species, there are one or two generations each year.

## Vegetable crop pests—Garden symphylan

*Scutigera* *immaculata*

**Pest description and crop damage** Garden symphylans also are called garden centipedes. When full grown, they are not more than 0.32 inch long, have 15 body segments, and 11 or 12 pairs of legs. They are slender, elongated, and white with prominent antennae.

Symphylans may damage sprouting seeds, seedlings before or after emergence, or older plants. They feed primarily on root hairs and rootlets. Their ability to injure the crop decreases as plants get larger; however, their pitting of older roots may provide entry for pathogens. Transplants may be stunted by their feeding as new roots attempt to grow out of the transplant plug.

**Biology and life history** Eggs, nymphs, and adults can be found in any month of the year, but the majority of eggs are found during the early spring and fall. Nymphs and adults become active in the spring in the top 8 inches of soil. Eggs are laid in clusters of 4 to 25. Eggs hatch in about 40 days, and nymphs begin feeding on small roots. The total development time from egg to adult is about 5 months at 50°F. There are one or two generations each year.

See:

Biology and Control of the Garden Symphylan

## Vegetable crop pests—Grasshopper

Many species

**Pest description and crop damage** Grasshoppers eat irregular holes in leaf tissue and can defoliate plants in high numbers, especially when swarming. Damage tends to be greatest on the edges of fields near pasture areas or roadsides. When wild grasses and other plants become dry, grasshoppers migrate to irrigated croplands.

**Biology and life history** Most grasshoppers overwinter in the egg stage in the soil. Eggs are laid in pods in the soil during late summer and fall, and nymphs emerge in April, May, and June. Nymphs feed on vegetation for 40 to 60 days before molting into the adult stage. Adults disperse to suitable hosts during the summer and can do serious damage to crops and rangeland. Adults mate in late summer and lay the overwintering eggs in waste areas and around field margins

## Vegetable crop pests—Imported cabbageworm

*Pieris rapae*

**Pest description and crop damage** Larvae are green and very hairy, with an almost velvetlike appearance. They often have one faint yellow-orange stripe down their backs and broken stripes along the sides. Older larvae may be up to 1 inch long. Compared to other caterpillars, cabbageworms move slowly and are sluggish, but feed voraciously. Larvae pupate by attaching a few strands of silk to stems or other nearby objects. Pupae are green with faint yellow lines down the back and sides; there is no spun cocoon. The adult cabbage butterfly is white with one to four black spots on the wings. They often are seen fluttering around the fields. The whitish, rocket-shaped eggs are laid singly on the undersides of leaves.

In the Pacific Northwest, imported cabbageworm causes most of its damage by contaminating plants with pupae in harvested parts of the crop. Larvae do chew large, irregular holes in leaves, bore into heads, drop greenish brown fecal pellets that may contaminate the marketed product, and seedlings may be damaged, but most losses are due to contamination or damage to marketed parts of the plant.

**Biology and life history** The imported cabbageworm overwinters in the pupal stage on host plants. Adults emerge in late April and May and lay eggs singly on the undersides of outer leaves. The border rows of crops may receive more eggs than the center rows. Eggs hatch in 4 to 8 days, and larvae mature in 2 to 3 weeks, then pupate on the host plant. The time required for development from egg to adult is 3 to 6 weeks. Adults emerge in 1 to 2 weeks, mate, and lay eggs for another generation. There are three to five generations each year.

## Vegetable crop pests—Leafhopper

**Includes** six-spotted leafhopper (*Macrostelus fascifrons*)

**Pest description and crop damage** The six-spotted leafhopper is also known as the aster leafhopper. It is about 0.19 inch long, narrow, wedge-shaped, with a beak, tiny antennae, and long hind legs fringed with hairs. It is yellow or yellow-green with six black spots arranged in three rows on its head. Eggs are translucent at first but soon turn white.

Adult leafhoppers have wings. They are relatively poor fliers and tend to glide along with wind currents. Nymphs have only wing pads and cannot fly. Wingless nymphs resemble adults but are much smaller, ranging in size from 0.03 to 0.25 inch long. They often can be distinguished by their unique sideways scuttle when disturbed. Young larvae are white but soon become yellow with brown markings.

Feeding damage causes a yellow, speckled appearance. This is usually minor. The six-spotted leafhopper is the primary vector of aster yellows phytoplasma, a serious virus-like plant disease.

**Biology and life history** The six-spotted leafhopper overwinters as an egg in northern locations and in the adult stage in warmer climates. It undergoes a series of five nymphal stages before reaching adulthood. Each generation requires 27 to 34 days. There are three to four generations each year.

## Vegetable crop pests—Looper

**Includes**

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

**Pest description and crop damage** Alfalfa looper adults are brownish moths with distinctive silvery figures on the front wings. Eggs are ridged and dome-shaped and usually laid singly on the undersurface of leaves. Loopers are smooth-skinned with only a few long bristles down the back. They are green, usually with a narrow white stripe along each side and several narrow lines down the back. They may grow up to 1.5 inches long. Alfalfa loopers tend to have more dark markings than cabbage loopers. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Looper caterpillars can be distinguished from most other common caterpillars by their distinctive looping movement, in which they arch the middle portion of their body to bring the hind legs forward to meet the front legs. Cabbage looper larvae are pale green and have a narrow white stripe along each side and several down the back. They can be up to 1.5 inches long. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Adults are brown moths with distinctive silvery figures on the front wings. Loopers can be distinguished from other caterpillars by their distinctive looping movement, in which they arch the middle of their bodies so their front legs meet their back legs.

Looper larvae feed on leaves, causing ragged-edge holes in the leaf and on the leaf margins. The major damage caused by larvae and pupae is contamination of the heads and severe defoliation. Alfalfa loopers tend to do less physical damage to plants, but are a serious source of contamination. The major damage caused by larvae and pupae is contamination of the heads of cole crops and severe defoliation of alfalfa, peas, sugar beets, beans, mint, and spinach.

## Vegetable crop pests—Lygus bug

*Lygus* spp.

**Pest description and crop damage** The lygus bug adult is about 0.25 inch long and about half as wide. It is generally brownish with a prominent, V-shaped yellowish area near the center of the body, at the base of the wings. Eggs are bean-shaped, with the outer end blunt or squarely cut off. They are very difficult to spot. Nymphs are yellow-green at first but darken rapidly. They have four dots, often black, on the thorax, and one on the abdominal base. Antennae of the young are generally reddish.

Lygus bugs cause different types of damage to different stages and different crops. They cause blackheart on celery, blasting on flower tissues, collapse of asparagus spears, decreased yields in seed production in carrot and cabbage, and damage to blossoms and pods on beans.

**Biology and life history** Lygus bugs overwinter in trash along field margins and roadsides. Adults become active in late May and early June and disperse into crops. Adults mate and females start laying eggs on plant stems. Eggs hatch in 1 to 3 weeks into nymphs. Nymphs feed on plant juices for 2 to 3 weeks before molting into the adult stage. There are usually three or four generations each year.

## Vegetable crop pests—Seedcorn maggot

*Delia platura*

**Pest description and crop damage** The seedcorn maggot adult is a slender, light gray fly, about 0.19 inch long. It looks much like a small housefly. The whitish eggs have slightly raised ridges running their length and width forming tiny rectangles. Larvae are about 0.25 inch long, white to whitish yellow, cylindrical, and tapered, the smaller end in front. Pupae are small brown capsules. The seedcorn maggot is abundant during or following a wet cycle, primarily in spring, and is most common in fields containing a high amount of residue from a previous crop or where manure has been spread.

Seedcorn maggots burrow into seeds and developing embryos in the ground, damaging and destroying seeds and creating sites for rot. They may spread bacterial soft rot.

**Biology and life history** The seedcorn maggot overwinters as a pupa in the soil. Adults emerge in early May and lay eggs singly or in clusters in the soil near plant stems. They prefer soils with high levels of organic matter. Eggs hatch in 7 to 10 days, and the larvae feed for 1 to 3 weeks on seeds and germinating seedlings. Then, they burrow into the soil to pupate. They emerge as adults in late June and early July. Adults lay eggs as before,

and larvae feed to maturity and pupate in August to form the overwintering stage.

Weather conditions are important in the development, activity, and abundance of the seedcorn maggot. Development is slowed greatly at average temperatures below 45°F or above 75°F. There may be as many as five generations each year.

## Vegetable crop pests—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

**Pest description and crop damage** Slugs are related closely to snails but have no shell. They are active above ground primarily at night, and also during mild, wet periods, at any time of year. Very little activity takes place in cold, freezing, or extremely hot weather. During the day, slugs usually are found in the soil or in crevices or cracks, to protect themselves from dehydration and predators.

Slug damage can be distinguished easily from damage caused by other pests by the presence of slime trails. Damage to roots and tubers is characterized by smooth sided pits 0.12 to 0.5 inch in diameter. Damage to foliage is removal of plant tissue between veins and on the edge of leaves. Slug damage tends to be heaviest along field margins. Weedy or grassy borders serve as excellent habitat for slugs. High populations build up in perennial legumes used for cover crops.

**Biology and life history** Slugs are hermaphrodites. Each individual is capable of laying eggs. The small, round, pearl-like white or translucent eggs are laid in clusters of a dozen or more in sheltered cavities near the soil surface or under thick mulch on the soil surface if the soil is moist. Eggs hatch in 2 to 4 weeks. Egg laying activity is greatest after the first late summer and fall rains. Eggs overwinter if they are laid in October or November. The gray garden slug lays additional clutches of eggs in early spring. Slugs can live up to 12 months.

*See:*

Slug Control

## Vegetable crop pests—Spider mite

### Includes

Pacific spider mite (*Tetranychus pacificus*)

Strawberry spider mite (*Tetranychus turkestanii*)

Twospotted spider mite (*Tetranychus urticae*)

**Pest description and crop damage** Several species of spider mites are common in the Pacific Northwest. Frequently, infestations include a mixture of spider mite species.

Adult mites are about 0.06 inch long, have four pairs of legs, are greenish to pink or cream color, and have various-size black spots on the body. Under warm conditions, spider mites move rapidly within the colony area.

Damaged leaves become somewhat stippled on the upper surface and may turn brown or bronze with heavy damage. The undersurface of leaves may have a grayish cast due to webbing. Wilting, leaf deformity, tissue death, and abscission all may take place. (Trivia fact: Twospotted spider mites can feed on 18 to 22 plant cells per minute.)

**Biology and life history** Spider mites have four stages of development: the oval, somewhat translucent egg; a six-leg translucent larval stage; an eight-leg nymph stage; and the eight-leg adult stage. A resting or quiescent stage occurs at the end of the larval and nymph stages. A generation may pass in as few as 5 to 7 days in midsummer, or in a month during cool periods. There are numerous overlapping generations each year.

## Vegetable crop pests—Squash bug

*Anasa tristis*

**Pest description and crop damage** The adult squash bug is flat-backed, brownish black, and measures about 0.62 inch long. Eggs are elliptical and yellowish-brown turning dark brown with age. The nymphs have a green abdomen with crimson head, thorax, antennae, and legs which soon darken to reddish brown. Older nymphs are grayish white with black legs and antennae. Nymphs range from 0.19 to 0.5 inch long. Squash bugs feed primarily on squash and pumpkin. Adults and nymphs suck plant sap from the leaves and stems, causing wilting and death. Damage tends to be localized.

**Biology and life history** Squash bugs overwinter in protected places as unmated adults. They appear rather slowly in the spring. Adults mate and begin laying clusters of eggs about the time the squash vines begin to spread. Eggs are laid in clusters of a dozen or more on the leaves. They hatch in about 10 days into nymphs. Nymphs go through five molts before becoming adults in 4 to 6 weeks. There is only one generation per year.

## Vegetable crop pests—Thrips

### Includes

Corn thrips (*Frankliniella williamsi*)

Onion thrips (*Thrips tabaci*)

Western flower thrips (*Frankliniella occidentalis*)

**Pest description and crop damage** Thrips are small insects about 0.03 inch long. Adult thrips have two pairs of narrow wings which are fringed with hairs. Immature thrips are wingless, whitish to yellowish in color, and are most commonly found in whorls, tassels, ears, or on the underside of leaves. Thrips are not generally considered a serious pest of sweet corn grown for processing. Thrips damage on corn seedlings causes stunting. If thrips infestations are severe during the establishment period (the first 3 to 4 weeks after planting), treatment may be justified. Thrips are known to vector a number of important plant viruses, including tomato spotted wilt virus and iris yellow spot virus. They are a serious pest of fresh market sweet corn, because they cause cosmetic damage to the ear including white or silver blotches. Foliage-feeding thrips are predators of spider mites and can help with early year control of spider mite populations. Thrips are the key pest of dry bulb onions, causing extensive stippling and yield reductions up to 35%.

## Vegetable crop pests—Western bean cutworm

*Loxagrotis albicosta*

**Pest description and crop damage** The adult is a brownish moth with a wingspan of about 1.5 inches. It has a broad white or tan stripe along the leading edge of its wing. Eggs are white at first, turning pink and finally purplish gray, with well marked ridges. Larvae are brownish and 1.25 inches long at maturity. The pupa is dark brown, about 0.75 inch long, and is found in a cell made of saliva and soil particles. Larvae tend to damage bean pods and not the beans themselves. But, they do feed on drying beans in hedgerows. They are a pest only in south-central Idaho.

**Biology and life history** The western bean cutworm overwinters as a mature larvae in an earthen cell in the ground. Pupation occurs the following spring. Adults emerge in early July through August. Eggs are laid in masses about 3 days after the adults emerge, and begin hatching in about 6 days. Larvae are present from late July to late September. After hatching, young larvae may feed on leaf surfaces for a while. Older larvae drop to the ground, tunnel in, and emerge at night to feed. They then enter the soil to overwinter. There is one generation each year.

## Vegetable crop pests—Whitefly

Greenhouse whitefly (*Trialeurodes vaporariorum*)

Silverleaf whitefly (*Bemesia argentifolii*)

Sweetpotato whitefly (*Bemesia tabaci*)

**Pest description and crop damage** Adult is white and very small; it looks like a miniature moth. They typically feed on the undersides of leaves, flying up in clouds when disturbed. Immature stages are flat, oval, white to greenish, and semitransparent. Eggs are white and laid singly on white, chalky-looking spots on the lower leaf surface. Whiteflies feed by sucking sap from the plants. Damaged leaves wilt, turn yellow or brown, and may drop, all of which reduces photosynthetic area and weakens the plant. Plants may be stunted by severe infestations. Whiteflies also produce honeydew, which may attract ants or become covered with a growth of sooty mold.

## Vegetable crop pests—Wireworm

*Ctenicera* spp. and *Limonius* spp.

**Pest description and crop damage** Wireworms are the most important soil-dwelling pests infesting crops in the Pacific Northwest. The adults, known as click beetles or snapping beetles (*Elateridae* family), do little or no damage. The larval or immature stages cause major damage to seedlings and the underground portions of many annual crops. The larvae are shiny white at first, but later become straw color or light brown. They look wiry and are about 1 inch long when mature.

Several kinds of wireworms are in the Pacific Northwest. Those causing the most damage in irrigated land are the Pacific Coast wireworm (*Limonius canus*), the sugar beet wireworm (*L. californicus*), the western field wireworm (*L. infuscatus*), and the Columbia Basin wireworm (*L. subauratus*). Of these Pacific Coast and sugar beet wireworms are the most common species. Land with annual rainfall less than 15 inches may be infested with the Great Basin wireworm (*Ctenicera pruinina*). As a result, there may be serious damage when irrigated crops are grown on sagebrush or dry wheat land. This species tends to disappear after a few years of intensive irrigation, but may be replaced by the more serious *Limonius* species, which favor moist conditions. West of the Cascades, other species of wireworms, including *Agriotes* spp., are pests.

No crop is immune to attack by wireworms, but these pests are most destructive on beans, corn, grain, potatoes, and other annual crops. Damage caused by wireworms in other crops includes failure of seeds to germinate (due to feeding on planted seeds) and death of young plants (due to root feeding). In potatoes, serious damage results from wireworms tunneling in tubers during feeding. In row crops, such as beans, corn, and sugar beets, infestation results in bare spots of fields, which is accompanied by dead or wilted young plants. Wireworms damage potatoes both near planting time (from damage to seed pieces) and during the growing season (from damage to developing tubers).

**Biology and life history** Wireworms require two to six years to mature. They overwinter 12 to 24 inches deep in the soil and return near the surface in spring to resume feeding. Mature larvae pupate in the soil, then develop into adults that will remain in the soil until the following spring, when they emerge, mate, and lay eggs. Because the female beetles fly very little, infestations do not spread rapidly from field to field.

Soil temperature is important to wireworm development and control. Larvae start to move upward in the spring, when soil temperature at the 6 inch depth reaches 50°F. Later in the season, when temperatures reach 80°F and above, the larvae tend to move deeper than 6 inches, where most remain until the following spring.

# Hosts and Pests of Vegetable Crops

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## ***INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE***

### **Artichoke (globe artichoke)—Aphid**

#### **Includes**

Artichoke aphid (*Capitophorous elaeagni*)

Erigeron root aphid (*Aphis middletonii*)

Green peach aphid (*Myzus persicae*)

Thistle aphid (*Brachycaudus cardui*)

**Pest description and crop damage** Artichoke aphids are pale, almost translucent aphids with distinctly dusky-colored cornicles and diverging tubercles at the base of the antennae. Thistle aphids are small yellow or green plant lice. The upper surface of the abdomen of the adult *B. cardui* is black. Adults with black crossbars on the abdomen are *A. middletonii*. The green peach aphid is slender, dark green to yellow, with converging tubercles and no waxy bloom. It is primarily an early-year pest. Aphid infestations may result in wilting, leaf curling, weakened bud stalks, and slowed growth.

#### **Biology and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently during the early growing year and after seedling emergence in annual artichoke plantings. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May. Green peach aphids may move into fields early in the year. They do not transmit significant viruses to artichokes, and they rarely require treatment. Early year aphids have many natural enemies.

#### **Management—biological control**

Many parasites and predators attack aphids. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*. Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

#### **Management—cultural control**

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts, especially thistles, late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen.

*Home gardeners* can often get effective control by washing aphids with a strong stream of water.

#### **Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- deltamethrin
- esfenvalerate
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (peppermint, rosemary oil, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin/imidacloprid (Brigadier) at 0.1 to 0.2 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin. Retreatment interval 15 days.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- imidacloprid (Admire Pro) at 0.25 to 0.5 lb ai/a soil application in furrow or chemigation or at 0.05 to 0.125 lb ai/a foliar. REI 12 hr. PHI 7 days. Retreatment interval 14 days. Do not exceed 0.5 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- spirotetramat (Movento) at 0.08 to 0.13 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- thiamethoxam (Actara) at 0.047 lb ai/a. PHI 4 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.094 lb ai/a per season.

## Artichoke (globe artichoke)—Artichoke plume moth

*Platyptilia carduidactylus*

**Pest description and crop damage** Adults of the artichoke plume moth vary in color from buff to brownish buff, with a wingspan of 0.75 to 1.25 inches. The wings are divided into lobes, giving the appearance of several pairs of wings; the hind wings are fringed. Eggs are light greenish-yellow at first, turning darker (orange-yellow) with age, shiny, and very small.

Artichoke plume moth is primarily a problem where artichokes are grown as perennials. Larvae feed on all parts of the plant, but economic damage occurs when they feed on the floral buds and render them unmarketable.

**Biology and life history** Eggs usually are laid singly on the underside of leaves and occasionally on the bud stalk. Upon hatching, tiny first instar larvae tend to feed externally. After the first molt, larvae start tunneling into the leaf stalk. With each subsequent molt, the larvae work their way toward the center of the bud.

Larvae undergo four to five instars. Larvae in the last instar are yellowish to pink at maturity and about 0.63 inch long. When close to pupation, larvae cease feeding, emerge from the feeding site, and generally drop to the ground.

Prepupae are very active in the early part of the stage and wander around in search of a suitable pupation site. Pupation generally occurs in plant debris, very often among folds of dried up leaves. The elongate pupae are pale yellowish brown, turning darker with age. There are three to four overlapping generations of the plume moth each year.

**Pest monitoring** When planting or replanting an artichoke field, consider soaking replant stumps in a solution of the insect-killing (entomopathogenic) nematode, *Steinernema carpocapsae*. If done correctly, this can reduce plume moth infestations to less than 1% and reduce the number of treatments required during the first year.

Pheromone traps can be used to detect adult activity. Trap catches of seven or more moths per week may indicate an impending problem.

Examine leaves weekly during summer, fall, and spring for eggs. Eggs are difficult to see, and some experience is required to make an accurate egg count. A count of 1 egg per 50 leaves indicates that there might be enough eggs present to produce an economic infestation. Examine individual shoots weekly for plume moth larvae. Determine the percent shoot infestation by sampling at least 50 shoots. An infestation of 3% or more requires treatment. Timing is critical: target the treatment against the first instar larvae. The most effective insecticides for artichoke plume moth control are those that kill the adult moths and the larval stage.

### Management—biological control

Natural enemies, especially parasitic wasps, attack the artichoke plume moth. But, they are seldom important in control, because the larva spends most of its time feeding within the plant, protected from natural enemies. Recently, in California, the egg parasite *Trichogramma thalense* was reported attacking plume moth that occurred on wild thistle. It may have applications in commercial releases.

### Management—cultural control

Sanitation can be an important factor in plume moth population dynamics. By cutting off the plants at ground level, shredding the tops, and incorporating the plant materials into the soil, artichoke plume moth infestations can be reduced by about 95%. However, the movement of the adults between fields makes the impact on any given field temporary.

During harvest, pick infested artichoke buds, regardless of stage of maturity, remove them from the field, and dispose of them.

### Management—chemical control: HOME USE

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- esfenvalerate
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- azadirachtin (Neemix) at 0.019 to 0.043 fl oz/a. PHI 0 days. REI 4 hr. Greenhouse only for transplanting to production fields. OMRI-listed for organic use. Registered in WA only.
- *Bacillus thuringiensis* (Javelin WG, Xentari) at 0.5 to 1.25 lb/a formulated product. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed

for organic use.

- bifenthrin (Brigade 2EC, Sniper) at 0.1 lb ai/a. PHI 5 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 15 days.
- bifenthrin/imidacloprid (Brigadier) at 0.1 to 0.2 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin. Retreatment interval 15 days.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 14 days. Do not exceed 4 applications per crop or 0.2 lb ai/a per crop.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.15 lb ai/a between bud formation and harvest.
- GS-omega/kappa-Hxtx-Hvla (Spear-Lep) at 1 to 2 pints product/a. PHI 0 day. REI 4 hr. Must be tank mixed with *Bacillus thuringiensis* (Bt) or other contact activity products to be effective.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.25 lb ai/a. PHI 4 days. REI 4 hr. Do not exceed 1.0 lb ai/a or four applications per season. Addition of adjuvant improves performance.
- permethrin (Pounce 25WP) at 0.1 to 0.3 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 1.5 lb ai/a (Ambush) or 0.9 lb ai/a (Pounce) per year. Retreatment interval 10 days.
- pyriproxyfen (Knack) at 0.05 to 0.067 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.134 lb ai/a per year or two applications per season. Retreatment interval 14 days.
- spinetoram (Radiant SC) at 0.0469 to 0.0625 lb ai/a. PHI 2 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 4 applications or 0.25 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success, Entrust SC) at 0.07 to 0.156 lb ai/a. PHI 2 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.33 lb ai/a per season. Limit 4 applications per crop. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang Maxx) at 0.025 lb ai/a. PHI 5 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.1 lb ai/a per season.

## Artichoke (globe artichoke)—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

**Pest monitoring** Pheromone traps can be used to monitor for cutworms prior to planting. If the cutworm population is reducing the plant stand after planting, treat during the early seedling stage. Frequently, the damage is most serious at the edges of a field, but stand loss can occur in a spotty pattern throughout the field. Usually, it is necessary to dig in the soil to find cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved. Larvae normally hide under debris on the soil surface during the day, but they are active, voracious feeders at night.

Since extensive damage may occur in a short period of time, inspect plant beds and newly set plants frequently. In North Carolina, an economic threshold of 5% injured plants is used for cutworms infesting newly set or young plants (within 3 weeks after transplanting). In Ontario, Canada, the guideline for black cutworm for many seedling vegetables is also 5% plants infested.

### Management—biological control

Cutworms are attacked by a number of predators, parasites, and diseases. Many of these natural control agents are not effective on pale western and black cutworms because of their subterranean nature. It is not known if any of these natural enemies can control cutworm populations, but their presence should be noted and taken into consideration when making a pesticide application decision. If pest numbers are relatively low and the natural enemy numbers are increasing, pesticide applications may be delayed. Keep scouting.

### Management—cultural control

Cutworms are most injurious in fields with high plant residue. Historically, cutworms are a problem in early, spring-seeded seedling fields. Tillage prior to seeding is effective in preventing cutworm damage. A thorough harrowing may provide adequate control when cutworms are feeding actively in established fields. Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (sometimes as a mix with zeta-cypermethrin)
- deltamethrin
- esfenvalerate
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad (as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- *Bacillus thuringiensis* ssp. *kurstaki* or *aizawai* (Javelin WG, Xentari) at 0.5 to 1.25 lb/a formulated product. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- permethrin (Loveland Permethrin Cutworm bait) at 0.1 to 0.3 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.9 lb ai/a per season. Retreatment interval 10 days. Limit 3 treatments per season.

See:

Corn, sweet—Cutworms

## Artichoke (globe artichoke)—Painted lady or thistle butterfly

*Vanessa cardui*

**Pest description and crop damage** Painted ladies are orange-brown butterflies with a wingspan of up to 2.87 inches. Wings have a black apex patch and white bar on the leading edge. Caterpillars are spiny, dull brown to black, with a pale yellow stripe on each side. They feed mostly on thistle. It is only an occasional pest of artichokes.

**Biology and life history** Male butterflies perch and patrol during the afternoon for receptive females. They usually perch on shrubs on hilltops. Females lay eggs singly on the tops of host plant leaves. Caterpillars live in silk nests and eat leaves. Adults hibernate only in the South and in mild winters. There are one to three flights each year.

### Management—chemical control: HOME USE

- bifenthrin (as a mix with zeta-cypermethrin)

### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin WG, Xentari) at 0.5 to 1.5 lb/a formulated product. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade2EC, Sniper) at 0.033 to 0.1 lb ai/a. PHI 5 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.15 lb ai/a between bud formation and harvest.
- zeta-cypermethrin (Mustang Maxx) at 0.025 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.1 lb ai/a per season.

## Artichoke (globe artichoke)—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Slug Control

**Pest monitoring** A simple but effective method for monitoring slugs is to place a handful of slug bait under pieces of scrap wood in the field after an inch or two of rain in late August or September. This also should reveal the presence of juvenile slugs. Slugs are particularly active on mild, damp evenings.

### Management—cultural control

Slugs tend to be of greater concern on heavy soils, especially if the soil remains in large aggregates which provide slugs with shelter. Dense stands of weeds in field margins encourage populations to build up. Sanitation is important, as it removes food sources and hiding places. Drip irrigation lowers ambient humidity. Rotovating during periods of egg laying can reduce egg numbers.

### Management—biological control

Ducks (particularly female mallards) can be confined in the planting periodically. They seek out and eat small slugs.

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron (ferric) phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

### Management—chemical control: COMMERCIAL USE

- metaldehyde baits—Do not contaminate edible plant parts. Use as needed, but not more often than once per week.

## Asparagus—Aphid

**Includes** asparagus aphid (*Brachycorynella asparagi*)

**Pest description and crop damage** Aphids feed on the fern and severely stunt growth. On mature fern, injury is a “tufting” of shoot growth beyond the point of injury. New shoots emerging from a plant with a heavy aphid infestation have shortened internodes and very small cladophylls, which produce a very dense clump of fern growth. Damage appears greatest to young plants. Nurseries with ferns infested in summer or fall may have 90 to 100% crown mortality the following spring. Mature stands may show loss of vigor and production.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

Asparagus aphid is somewhat unusual in that it spends its entire life cycle on asparagus. It overwinters in the egg stage on the foliage. Eggs hatch in early spring to produce wingless “stem mothers” which produce repeated generations of winged and wingless females throughout the spring and summer. In the fall sexual forms are produced and overwintering eggs are laid.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

*Dormant-season spray*

- superior-type oil—Effective on any overwintering eggs found on plant debris. Some formulations are OMRI-listed for organic use.

*Growing-season-spray*

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (peppermint, rosemary oil, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30 SG) at 0.047 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season. Limit 2 treatments.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- insecticidal soap (M-Pede) at 1 to 2% v/v solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Fyfanon 8) at 1 to 1.25 lb ai/a. PHI 1 day. REI 12 hr. Apply by air or ground. Do not exceed 2 treatment per season. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 170 days. REI 12 hr. Retreatment interval 30 days. Do not exceed 0.5 lb ai/a per season.

## Asparagus—Armyworm and cutworm

**Includes**

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)

### **Pest description and crop damage**

*See:*

Common Pests of Vegetable Crops

### **Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- insecticidal soap—Some formulations OMRI-listed for organic use.
- plant-derived essential oils (peppermint, rosemary oil, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations OMRI-listed for organic use

### **Management—chemical control: COMMERCIAL USE**

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help.

- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Product is only registered for use in WA.
- *Bacillus thuringiensis* (Javelin WG) at 0.12 to 1.5 lb formulated product/a. PHI 0 days. REI 4 hr. Add an appropriate spreader-sticker to enhance control. Spray and/or water mix should not exceed pH 8. Most effective on small larvae.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 4 applications per crop or 0.2 lb ai/a per crop. Armyworms only.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 4.5 lb ai/a per year. Do not exceed 8 applications per year.
- permethrin (Pounce 25WP) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/a per year. Retreatment interval 7 days.

## **Asparagus—Asparagus beetle**

*Crioceris asparagi*

**Pest description and crop damage** Asparagus beetle larvae are dark green-gray grubs about 0.33 inch long when fully grown. Adults are blue-black beetles with a red section on their backs (prothorax). Their wing covers have yellow spots and red borders. Asparagus beetle adults injure plants by feeding on the tips of tender young shoots. After leaves come out, asparagus beetles and their larvae gnaw on the surface of the stems and defoliate ferns. If injury to the fern is severe, the crown is weakened, particularly if the asparagus stand is young.

**Biology and life history** Adults overwinter in plant debris along field margins and fence rows and in hollow stems of old asparagus plants. Adults emerge in spring and deposit eggs singly or in rows on the shoots of the asparagus, making them unmarketable. Eggs hatch in 7 to 10 days, and larvae begin feeding on the young shoots. Larvae feed for 2 to 3 weeks before burrowing into the soil and pupating. Adults emerge in 1 or 2 weeks and deposit eggs for another generation. The entire life cycle takes about 1 month. There may be two or three generations each year.

**Pest monitoring** Monitor visually for adults early in the year. Populations tend to be clumped.

### **Management—biological control**

Larvae of lady beetles and predaceous plant bugs may reduce the number of larvae. In British Columbia, a parasitic chalcid wasp is common and may be important in regulating the population.

### **Management—cultural control**

Where asparagus is cut for market, injury may be reduced by cutting the crop clean every 3 to 5 days. Destroy volunteer plants and remove plant debris around field margins.

If beetles are feeding on spears early in the year, let some plants near the edge of the field produce fern growth to attract the beetles away from the

spears. Treat these areas.

**Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- carbaryl
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30 SG) at 0.047 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season. Limit 2 treatments.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- malathion (Fyfanon 8) at 1 to 1.25 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2 treatments per season. Retreatment interval 7 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 4.5 lb ai/a per year. Do not exceed 8 applications per year.
- spinetoram (Radiant SC) at 0.0313 to 0.0625 lb ai/a postharvest. PHI 60 days. REI 4 hr. Retreatment interval 4 days. Do not exceed three applications or 0.188 lb ai/a per season. Follow resistance management procedures on the label. Ferns only.
- spinosad (Success, Entrust SC) at 0.062 to 0.094 lb ai/a applied after harvest. PHI 60 days. REI 4 hr. Do not exceed three times per crop. Do not exceed 0.28 lb ai/a per crop. Do not feed treated ferns to meat or dairy animals. Ferns only. Entrust SC is OMRI-listed for organic use.

## Asparagus—Spotted asparagus beetle

*Crioceris duodecimpunctata*

**Pest description and crop damage** Adults are brick-red with six black spots on each wing cover. Eggs are green and deposited singly. Larvae are cream color with a light brown head. They most frequently are found inside the berry on female plants. Pupae are light yellow in a silken cocoon. Because larvae feed on the berries, infestations of the spotted asparagus beetle are less damaging than the asparagus beetle for fresh market and processing asparagus. However, the spotted asparagus beetle can be a major pest in seed production fields.

**Biology and life history** The spotted asparagus beetle overwinters as an adult and begins feeding immediately following emergence. Egg laying starts approximately 1 week after emergence. Eggs are oval and attached to the fern plant by the side. Larval feeding takes place primarily in the berry and lasts for 10 to 14 days and four instars. Mature larvae crawl to the ground and burrow within the soil, where they spin a silken cocoon in which to pupate. There are usually two generations each year.

**Pest monitoring** Spotted asparagus beetle adults rarely do damage to the spears and do not need to be treated. Larvae damage to seeds is of concern only when asparagus is grown for seed production.

**Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- carbaryl
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.047 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season. Limit 2 treatments.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- malathion (Fyfanon 8) at 1 to 1.25 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2 treatments per season. Retreatment interval 7 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 4.5 lb ai/a per year. Do not exceed 8 applications per year.
- spinetoram (Radiant SC) at 0.031 to 0.063 lb ai/a postharvest. PHI 60 days. REI 4 hr. Retreatment interval 4 days. Do not exceed three applications or 0.188 lb ai/a per season. Follow resistance management procedures on the label. Ferns only.
- spinosad (Success, Entrust SC) at 0.062 to 0.094 lb ai/a applied after harvest. PHI 60 days. REI 4 hr. Do not exceed three applications per crop. Do not exceed 0.28 lb ai/a per crop. Do not feed treated ferns to meat or dairy animals. Ferns only. Entrust SC is OMRI-listed for organic use.

## Asparagus—Garden symphylan

*Scutigera immaculata*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Apply preplant only.

## Asparagus—Wireworm

*Ctenicera* spp. and *Limonius* spp.

### Pest description and crop damage

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (neem oil as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

## Bean, dry—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Pea aphid (*Acyrtosiphon pisum*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous increase frequency of sampling. Aphids often are concentrated in hot spots. Note the presence of any hot spots but avoid sampling only those areas. Also, be sure to look for evidence of biological control – i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80° F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early season aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae.

Monitor the proportion of aphid mummies relative to un-parasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent aphid dispersal. Destroying weed hosts late in the year may help destroy overwintering

populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases.

*Home gardeners* can often get effective control by washing aphids from plants with a strong stream of water.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (sometimes as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use. Only registered in WA.
- carbaryl
- esfenvalerate
- imidacloprid
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage and stems. Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- borate complex (Prev-Am) at 0.4% to 0.8% solution. Spray until coverage is complete. PHI not listed. REI 12 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days. REI 48 hr. Do not feed treated vines. Highly toxic to bees.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze treated vines.
- flupyradifurone (Sivanto 200SL) at 7 to 10.5 fl oz/a. PHI 7 days. REI 4 hr. Do not exceed 0.365 lb ai/a per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a. PHI 21 days. REI 12 hr. Soil application only. Do not exceed 0.375 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 14 days to harvest and for feeding vines or hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phorate (Thimet 20-G) at 0.0563 to 0.0875 lb ai/1,000 ft row at planting. Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.
- spirotetremat (Movento HL) at 2.5 fl oz/a. PHI 7 days. Retreatment interval 7 days. REI 24 hr
- sulfoxaflor (Transform WG) at 0.75 to 1.0 oz/a. Do not exceed 8.5 oz/a. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 ft out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed.
- zeta-cypermethrin (Mustang; Mustang Max) at 0.02 to 0.025 lb ai/a (Mustang Max) or 0.04 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per season. Retreatment interval 5 days. Do not apply within 25 ft of an aquatic habitat by ground application, 150 ft if applied by air.

## **Bean, dry—Armyworm and cutworm**

### **Includes**

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agrotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight (as they are nocturnal) to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Bt*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl—To avoid harming bees, do not apply products containing carbaryl to plants in bloom.
- esfenvalerate
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.75 to 1 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- *Bacillus thuringiensis* (Javelin)—See product labels for rates. PHI 0 days. REI 4 hr. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.0065 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze treated vines.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 1.5 lb ai/a. PHI 7 days. REI 12 hr.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 14 days to harvest, feeding vines, or hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- novaluron (Rimon .83 EC) at 6 to 12 fl oz/a. Do not apply more than 36 fl oz/a per season. PHI 24 hr. REI 12 hr.
- spinetoram (Radiant SC) at 0.0313 to 0.0625 lb ai/a. PHI 28 days. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.094 lb ai/a per season. Follow resistance management procedures on the label.
- zeta-cypermethrin (Mustang; Mustang Max) at 0.008 to 0.025 lb ai/a (Mustang Max) or 0.016 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## **Bean, dry—Corn earworm**

*Helicoverpa zea*

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

#### **Management—biological control**

Many predators and parasites attack corn earworm eggs, including several species of Trichogramma wasps. Most parasitized eggs turn black, but there may be a lag period before they do so. Commercial releases of Trichogramma wasps have been used with mixed results. Generalist predators such as lacewings, minute pirate bugs, and damsel bugs feed on corn earworm eggs and small larvae.

- HCNPV (Gemstar LC) at 4 to 10 fl oz formulated product. PHI 0 days. REI 4 hr. A liquid concentrate biological insecticide for control of corn earworm.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)
- carbaryl
- esfenvalerate
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.75 to 1 lb/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.

- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a. PHI 1 day. REI 4 hours. Do not exceed a total of 0.2 lb ai of chlorantraniliprole per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze treated vines.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 14 days for harvest, feeding vines, and hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- spinetoram (Radiant SC) at 0.0313 to .0625 lb ai/a. PHI 28 days. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.094 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 28 days. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.188 lb ai/a per year. Do not feed forage or hay to livestock. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang; Mustang Max) at 0.017 to 0.025 lb/a (Mustang Max) or 0.035 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per year. Do not apply by foliar application within 25 ft of an aquatic habitat, or 150 ft if applied by air.

## Bean, dry—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Biology and life history** Cucumber beetles overwinter as fertilized females and are active beginning in early spring. Adults lay eggs at the base of plants. Eggs hatch in 7 to 10 days, and larvae feed in roots for about three weeks before pupating in the soil. Adults emerge in two weeks and begin feeding on pollen, plant foliage, flowers, and pods. It takes 30 to 60 days to complete a life cycle. There are two generations per year.

**Pest monitoring** Specific treatment thresholds have not been established for these foliage feeders in Oregon. In Virginia, the following recommendations are made: To prevent cucumber beetle damage to seedlings, treat when one beetle per 10 row ft is found. If damaging numbers are found during mid-year, excessive foliage loss may reduce crop production.

Sweep fields with a standard sweep net prior to first bloom. When one finds an average of two to four beetles per arc of the sweep net, treatment is justified.

Be aware of surrounding fields. As grass fields dry down before harvest, and when harvested vegetable crops are disked into the soil, sudden surges in beetle pressure may occur as beetles migrate in from other areas.

Experimental use of yellow sticky traps placed in the field just above the crop canopy suggests that, on average, if counts exceed two beetles per trap per day, treatment is justified if the crop is in a susceptible stage. A minimum action threshold has not been established. If trap counts are less than two beetles per trap per day, use a sweep net to make treatment decisions.

### Management—cultural control

In most years, low ebbs occur in the aboveground adult beetle populations after egg laying and before the summer generation emerges. Sometimes, a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Trap-and-spray crops sometimes can be used to draw beetles away from the main crop or to intercept incoming beetles at the edge of the field. Trap-cropping is an unproven technique in the PNW.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- esfenvalerate
- imidacloprid
- malathion
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 0.61lbs/ai/Aai/a. PHI 1 day. REI 12 hr. Do not graze or feed treated crop foliage to livestock.

- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/a. PHI 14 days for harvest, feeding vines, and hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- zeta-cypermethrin (Mustang Max; Mustang) at 0.017 to 0.025 lb ai/a (Mustang Max) or 0.035 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Bean, dry—Grasshopper

Many species

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological control

Predators and parasites of grasshoppers are numerous and at times play an important role in maintaining grasshopper populations at low densities. Unfortunately, under favorable weather conditions, population increases may overwhelm the natural controls, and grasshoppers may reach high densities.

A biological control that has been tested extensively and is commercially available is the protozoan *Nosema locustae* (Nolo Bait). Nolo Bait has an REI of 4 hr and is slow acting. It may not reduce grasshopper populations to subeconomic numbers the year of application. It is more effective applied to uncultivated areas such as field borders and pastures where grasshoppers breed. The timing of application is also important.

### Management—cultural control

Disturbance or maturation of crops may cause grasshoppers to disperse. Take care not to cut vegetation or till soil of fields harboring grasshoppers if susceptible crops are being grown nearby. Large blocks of crops with less crop edge tend to be damaged less than smaller blocks.

### Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden as allowed per label when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- esfenvalerate
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days. REI 48 hr. Do not feed treated vines.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Apply reduced rates (0.02 to 0.03 lb ai/a) to first and second instar larvae. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze treated vines.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat by ground application, or 150 ft if applied by air.

## Bean, dry—Lygus bug

*Lygus* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Sweep nets can be used to sample for lygus bugs. In the Pacific Northwest, a suggested treatment threshold is one-half adult or one-half for fourth or fifth instar nymph, per sweep. In California, for dry beans, treatment thresholds vary depending on the variety and the stage of the crop, from one-half to two lygus bugs per sweep.

### Management—biological control

Generalist predators, such as lacewings, big eyed bugs, and damsel bugs, may prey on lygus bug nymphs. Parasitic wasps may also prey on lygus such as *Peristenus* spp. Conserve populations of these biological control agents by minimizing applications of broad-spectrum insecticides.

## Management—cultural control

Lygus are likely to move when food sources become unsuitable. Common weeds that are good hosts of lygus bugs include pigweed, mustards, and wild radish. Mowed alfalfa fields nearby are commonly a source of large numbers of lygus bug adults moving into susceptible crops. There are a number of practices to reduce or control the movement of adults from alfalfa into nearby bean fields. These techniques leave uncut, tall alfalfa (attractive to lygus bug adults) within or near the cut area to serve as refugia for the insects.

## Management—chemical control: HOME USE

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- esfenvalerate
- malathion
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. Retreatment interval 14 days. Do not exceed 0.5 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 1.25 lb ai/a. PHI 1 day. REI 12 hr. Do not graze or feed foliage to livestock.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 14 days for harvest, feeding vines, and hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 24 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- novaluron (Rimon .83 EC) at 12 fl oz/a. Do not apply more than 36 fl oz/a per season. PHI 24 hr. REI 12 hr.
- phorate (Thimet) at 0.0563 to 0.0875 lb ai/1,000 ft row at planting; at no more than 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. At planting time only. Do not graze or feed to livestock. Toxic to fish and wildlife.
- Sulfoxaflor (Transform WG) at 1.5 to 2.25 oz/a. Do not exceed 8.5 oz/a. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 ft out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed.

## Bean, dry—Mexican bean beetle

*Epilachna varivestis*

**Pest description and crop damage** Adult beetles are about 0.25 inch long. They are dome-shaped and yellow to copper brown with eight small black spots in three rows across each wing cover. Eggs are small and yellow. The mature yellow larva is about 0.6 inch long and covered with dark, branched spines. Pupae are yellow to copper color and about 0.25 inch.

Both larvae and adults feed on the underside of leaves, leaving the upper surface intact. Damaged plants have a characteristic lace-like appearance. These remaining tissues die in about two days and turn brown, often giving the entire field a “burnt” cast. Pods and stems often are attacked, and shredded plants may die before any crop is matured. If overwintering populations are high, seedling damage may occur, though economic damage usually does not occur before August.

**Biology and life history** Adult beetles overwinter in hedgerows, ditch banks, and woodlands and may attack plants soon after seedlings emerge in spring. Most beetles leave their winter habitat over a two-month period.

Following feeding, adult females deposit eggs in clusters of 40 or more on the undersurface of leaves. Eggs hatch in 5 to 14 days, and larvae continue to feed for 2 to 5 weeks. Larvae pupate on leaves, and adults emerge after about 10 days. Adults feed, mate, and lay eggs over a period of two weeks. Generation time from egg to adult is about 30 days. There may be up to four generations each year.

**Pest monitoring** Eggs and larvae tend to be highly clustered. Sampling usually is done visually, though fields also can be swept.

## Management—biological control

Parasitic wasps (*Pediobius* spp.) are available for commercial release and have been used with success on the East Coast.

## Management—cultural control

Prompt removal of pods and destruction of old plants may help keep populations from building up. Because beetles are such strong fliers, crop rotation is probably not of much use.

## Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- esfenvalerate
- malathion

- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Toxic to bees, fish and aquatic invertebrates. Only registered for use in WA.
- esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze treated vines.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 1 to 1.5 lb ai/a. PHI 1 day. REI 12 hr. Do not graze or feed treated crop foliage to livestock.
- methomyl (Lannate SP) at 0.23 to 0.9 lb ai/a. PHI 14 days for harvest, feeding vines, and hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- phorate (Thimet 20-G) at no more than 2 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Sidedress at planting. Do not place in contact with seed. Do not graze or feed to livestock. Toxic to fish and wildlife.
- zeta-cypermethrin (Mustang Max; Mustang) at 0.017 to 0.025 lb/a or 0.035 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per year. Do not apply within 25 ft of an aquatic habitat by ground application, or 150 ft if applied by air.

## Bean, dry—Seedcorn maggot

*Delia platura*

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Slow emergence and poor stand establishment are signs of seedcorn maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence and increase susceptibility to seedcorn maggot infestation. To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply baker's yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult seedcorn maggot flies as they are attracted to carbon dioxide.

**Management—cultural control**

To reduce attractiveness of the field to egg-laying adults, disc or plow early in the year, incorporating residues from a previous crop and destroying weed growth. Plant under ideal soil and weather conditions to assure rapid seed germination and minimize seedcorn maggot damage.

One of the most reliable control methods is to plant seeds that have been treated with an appropriate insecticide in the seed box at planting. Most commercially available bean seed is treated with an insecticide to protect the seed from insect pests during storage. However, this treatment is not sufficient to provide field protection against seedcorn maggots. A planter box seed treatment insecticide at planting is recommended.

**Management—chemical control: HOME USE**

- bifenthrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- chlorpyrifos (Lorsban Advanced) as a broadcast or T-band treatment prior to planting. Consult label for rates. Do not exceed 0.94 lb ai/a per year.
- phorate (Thime-20G. Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.

## Bean, dry—Spider mite

**Includes**

Pacific spider mite (*Tetranychus pacificus*)

Strawberry spider mite (*Tetranychus turkestanii*)

Twospotted spider mite (*Tetranychus urticae*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** There is no precise survey technique for evaluating spider mite infestations. Infestations usually begin on the lower portions of the

plants and move upward as mite numbers increase. Evaluating spider mite infestations is most efficient if randomly selected, older, lower leaves are picked and inspected for stippling on the upper surface and webbing, mites, and feeding scars on the lower surface. Areas in the field where dust accumulates, or weedy areas are good places to scout for spider mites.

#### **Management—biological control**

Spider mite populations may be held at very low levels by a number of insect and mite predators, particularly early in the year. Thrips are effective early season predators, feeding primarily on spider mite eggs.

Commercial releases of predatory mites are used to control spider mites in greenhouses. In Florida, predatory mites were used to control spider mites in strawberries. Spider mites provide an important food source for predators such as minute pirate and bigeyed bugs.

#### **Management—cultural control**

Spider mite problems can be reduced by keeping fields and field margins clean of weed hosts. Spider mite populations may increase more rapidly in areas where dust deposits are heavy. Reducing dust may reduce the spider mite problem. Spider mites are usually less severe in sprinkler-irrigated fields than in drip or furrow-irrigated fields. Excessive nitrogen fertilization also may contribute to population buildup. Minimizing early year insecticide applications of broad spectrum insecticides, which reduce populations of beneficial insects, will reduce spider mite outbreaks.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Apply control measures when mites first appear, and repeat application as necessary. Good coverage, especially on undersides of leaves, is essential. Some formulations are OMRI-listed for organic use.
- plant essential oils (clove, garlic, rosemary etc.)—Some formulations are OMRI-listed for organic use.
- sulfur—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) 1.75 to 3.5 fl oz/a. PHI 7 days. REI 12 hrs. Do not exceed 10.25 fl oz/a per season. To avoid illegal residues, mix with a surfactant as recommended by the label.
- hexythiozox (Onager Optek) 10-24 fl oz/a, PHI 14 days. REI 12 hrs. Do not apply more than one application per season. Do not harvest or graze bean vines for hay or forage.
- insecticidal soap (M-Pede) at 1 to 2% (see label for gal/a). Potassium salts of fatty acids. PHI 0 days.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phorate (Thimet20-G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Use at planting only. Do not graze or feed to livestock. Toxic to fish and wildlife.
- propargite (Comite) at 1.6 to 2.4 lb ai/a. PHI 14 days. REI 9 days. Do not exceed 3.7 lb ai/a per season. Retreatment interval 21 days. Do not feed any parts of treated plants to livestock. Do not use more than twice per year.
- sulfur at 2.25 to 6.75 lb ai/a. REI 24 hr. PHI: consult processor.

## **Bean, dry—Thrips**

**Includes** *Thrips* spp. and *Frankliniella* spp.

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Treatment is usually not necessary on seedlings, because most plants recover from thrips injury. Thrips are also beneficial at this time because of their role as mite predators.

#### **Management—biological control**

Minute pirate bugs play a major role in controlling thrips populations.

#### **Management—cultural control**

Thrips populations tend to build up on weeds. Cultivating nearby weedy areas before the crop emerges reduces the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after crop emergence increases thrips problems.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- horticultural oil—Some formulations OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion
- plant essential oils (garlic, peppermint, rosemary, etc.)—Some formulations are OMRI-listed for organic use.

- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 1 to 1.75 lb ai/a. PHI 1 day. REI 12 hr.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 14 days for harvest, feeding vines, and hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- phorate (Thimet 20-G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. At planting time only. Do not graze or feed to livestock. Toxic to fish and wildlife.
- spinetoram (Radiant SC) at 0.039 to 0.0625 lb ai/a. PHI 28 days. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.094 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.07 to 0.09 lb ai/a. PHI 28 days. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.19 lb ai/a per year. Do not feed forage or hay to livestock. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Some formulations are OMRI-listed for organic use.
- spirotetremat (Movento HL) at 2.5 fl oz/a. PHI 7 days. Retreatment interval 7 days. REI 24 hr

## Bean, dry—Western bean cutworm

*Loxagrotis albicosta*

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Apply any of the recommended pesticides as allowed per label 10 to 20 days after the peak moth flight.

**Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them as they are nocturnal, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

**Management—chemical control: HOME USE**

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Bt*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl—To avoid harming bees, do not apply products containing carbaryl to plants in bloom.
- esfenvalerate
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad (as a mix with other ingredient)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not feed or graze livestock on treated vines.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Do not feed to or graze livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Bean, dry—Wireworm

*Ctenicera* spp. and *Limoniuss* spp.

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Test for wireworms before planting susceptible crops, especially where fallow land, pasture, or hay crops are being returned to vegetable production.

In the Midwest, bait stations are used widely to monitor for wireworms. An average of one wireworm per bait station might indicate the need for a preventive wireworm treatment. Ask your Extension agent for more information on bait stations. A pheromone is available for the Pacific Coast wireworm.

#### **Management—cultural control**

In fields known to contain wireworm larvae, fallowing during the summer with frequent tillage (springtooth or disk) can help. Seriously damaged stands of seedlings may need to be replanted. Use crop rotations to nonhost plants. Do not plant a susceptible host crop following a crop that has had a heavy infestation of wireworm without fallowing/tilling or applying a pesticide. Flooding a field for several weeks may reduce wireworm populations.

#### **Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

*See:*

Potato, Irish—Wireworm

## **Bean, lima—Aphid**

#### **Includes**

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Pea aphid (*Acyrtosiphon pisum*)

Potato aphid (*Macrosiphum euphorbiae*)

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

#### **Management—biological control**

Many parasites and predators attack aphids. Early season aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

#### **Management—cultural control**

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. *Home gardeners* can often get effective control by washing aphids with a strong stream of water.

#### **Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days, 1 days for lima beans harvested in succulent form. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- acetamiprid (Assail 30SG) at 0.047 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per season. Do not exceed 0.3 lb ai/a per season.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI after 4h. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade, Sniper) at 0.033 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days when harvested mechanically. REI 48 hr. Do not feed treated vines.

- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Dry beans only.
- flupyradifurone (Sivanto 200 SL) at 7 to 10.5 fl oz/a. PHI 21 days. REI 4 hr. Do not exceed 0.365 lb ai/a per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a soil applied only. PHI 21 days. REI 12 hr. Do not exceed 0.375 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for green beans, 21 days for dry beans. REI 24 hr. Do not feed to or graze livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for succulent beans, 14 days for dry beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per season.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phorate (Thimet 20\_G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.
- spirotetremat (Movento HL) at 2.5 fl oz/a. PHI 7 days. Retreatment interval 7 days. REI 24 hr
- sulfoxaflor (Transform WG) at 0.75 to 1.0 oz/a. Do not exceed 8.5 oz/a. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 ft out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed.
- zeta-cypermethrin (Mustang Max; Mustang) at 0.02 to 0.025 lb/a (Mustang Max) or 0.04 to 0.05 lb ai/a (Mustang). PHI 21 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a Mustang per season. Do not apply within 25 ft of an aquatic habitat by ground application, or 150 ft if applied by air.

## Bean, lima—Corn earworm

*Helicoverpa zea*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological control

Many predators and parasites attack corn earworm eggs, including several species of *Trichogramma*. Most parasitized eggs turn black, but there may be a lag period before they do so. Commercial releases of *Trichogramma* wasps have been used with mixed results. Generalist predators such as lacewings, minute pirate bugs, and damsel bugs feed on corn earworm eggs and small larvae.

- HCNPV (Gemstar LC) at 4 to 10 fl oz formulated product. PHI 0 days. REI 4 hr. A liquid concentrate biological insecticide for control of corn earworm.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- pyrethrins (sometimes combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (numerous products) at 0.75 to 1 lb ai/a. PHI 14 days, 1 day for lima beans harvested in succulent form. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Only registered for use in WA.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a. PHI 1 day. REI 4 hours. Do not exceed a total of 15.4 fl oz of chlorantraniliprole containing products per season.
- cyfluthrin (Tombstone) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.01 lb ai/a per season. Do not graze livestock or harvest for vines for forage or hay.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Dry beans only.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for green beans, 21 days for dry beans. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for succulent beans, 14 days for dry beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/a. PHI 7 days. REI 4 hr. Do not exceed 1 lb ai/a per season. Do not exceed four applications per season.
- spinetoram (Radiant SC) at 0.0313 to 0.0625 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.219 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 28 days for dry, 3 days for succulent. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.19 lb ai/a per year (dry) or 0.45 lb ai/a (succulent). Do not feed forage or hay to livestock. Spinosad takes several days to achieve

full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin (Mustang, Mustang Max) at 0.017 to 0.025 lb ai/a (Mustang Max) or 0.035 to 0.05 lb ai/a (Mustang). PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.15 lb ai/a (Mustang Max) or 0.3 lb ai/a (Mustang) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Bean, lima—Grasshopper

Many species

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological control

- *Nosema locustae* (Nolo Bait)—Use as manufacturer directs.

### Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden as allowed per label when young hoppers or winged adults are seen.

- azadirachtin (combined with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually combined with zeta-cypermethrin)
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (sometimes combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 14 days, 1 day for lima beans harvested in succulent form. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not feed treated vines or hay to livestock. Only registered for use in WA
- bifenthrin (Brigade 2EC, Sniper) at 0.025 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- cyfluthrin (Tombstone) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 14 days. Do not exceed 0.1 lb ai/a per season. Do not graze livestock or harvest for vines for forage or hay.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days when harvested mechanically. REI 48 hr. Do not feed treated vines.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Dry beans only.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for green beans, 21 days for dry beans. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Bean, lima—Leafhopper

**Includes** six-spotted leafhopper (*Macrostelus fascifrons*) and beet leafhopper (*Circulifer tenellus*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Leafhoppers are collected easily with sweep nets. Yellow sticky traps also are useful in monitoring.

### Management—cultural control

Mulches of aluminum foil and straw help reduce disease incidence. Row covers also can be used on higher value crops. Destruction of weed species known to harbor aster yellows is also important.

### Management—chemical control: HOME USE

- azadirachtin (combined with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually combined with zeta-cypermethrin)
- carbaryl
- imidacloprid
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (numerous products) at 0.5 to 1 lb ai/a. PHI 14 days, 1 day for lima beans harvested in succulent form. REI 24 hr. Do not feed treated vines. Do not exceed 2 lb ai/a per year.
- acetamiprid (Assail 30SG) at 0.044 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per season. Do not exceed 0.3 lb ai/a per season.
- bifenthrin (Capture, Sniper) at 0.025 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- cyfluthrin (Tombstone) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.06 lb ai/a per season. Do not graze livestock or harvest for vines for forage or hay.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days when harvested mechanically. REI 48 hr. Do not feed treated vines.
- esfenvalerate (Asana XL) at 0.015 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Dry beans only.
- flupyradifurone (Sivanto 200SL) at 7 to 10.5 fl oz/a. PHI 21 days. REI 4 hr. Do not exceed 0.365 lb ai/a per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.375 lb ai/a per season. Do not apply within 25 ft of aquatic habitat.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for green beans, 21 days for dry beans. REI 24 hr.

## Bean, lima—Lima bean pod borer

*Etiella zinckenella*

**Pest description and crop damage** The adult is a small brownish-gray moth with distinctive forward-protruding mouthparts and a broad white band on the leading edge of the wings. Eggs are tiny, white at first, turning pink, then gray. They are laid singly or in small clumps. Larvae are tiny and white at first, growing to up to 0.62 inch when mature and turning pink or tan. Larvae wriggle violently when disturbed. The pupa is up to 0.75 inch in a cocoon with soil particles adhering to it. Larvae bore through lima bean pods and eat the seed. It is seldom a pest of snap beans. Silk and droppings can contaminate pods, causing rejection from processors. Bush lima beans in the Columbia Basin have been injured seriously in recent years. Wild lupine seems to be a reservoir of infestation.

**Biology and life history** In California, overwintering larvae enter diapause in the fall, and pupate during winter. Adults emerge starting in March. The first generation feeds on wild lupines. The complete life cycle takes at least 60 days, sometimes much longer. In southern California, three to four generations occur.

**Pest monitoring** There is a sex pheromone that can be used for trapping adult male.

### Management—cultural control

Fall plowing to at least 8 inches deep can help destroy overwintering populations. Early year planting can help the crop achieve maturity before pod borers attain high densities. Crop rotation also is recommended where lima bean pod borers are a problem.

### Management—chemical control: HOME USE

- carbaryl

## Bean, lima—Lygus bug

*Lygus* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Sweep nets can be used to sample for lygus bugs. In the Pacific Northwest, a suggested treatment threshold is 0.5 adult or 0.5 fourth or fifth instar per sweep. In California, for dry beans, treatment thresholds vary depending on the variety and the stage of the crop, from 0.5 to 2 lygus bugs per sweep.

### Management—biological control

Generalist predators, such as lacewings and damsel bugs, may prey on lygus bug nymphs. Parasitic wasps may also prey on lygus such as *Peristenus* spp. Conserve populations of these biological control agents by minimizing applications of broad-spectrum insecticides.

### Management—cultural control

Lygus bugs are likely to move when other food sources become unsuitable. Common weeds that are good hosts of lygus bugs include pigweed and wild radish.

Mowed alfalfa fields nearby are commonly a source of large numbers of lygus bug adults. There are a number of practices to reduce or control the movement of adults from alfalfa into nearby bean fields. These techniques leave uncut, tall alfalfa (attractive to lygus bug adults) within or near the cut area.

### Management—chemical control: HOME USE

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- azadirachtin (combined with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually combined with zeta-cypermethrin)
- carbaryl
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days when harvested mechanically. REI 48 hr. Do not feed treated vines.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for green beans, 21 days for dry beans. REI 24 hr. Do not feed or graze livestock. Do not exceed 0.12 lb ai/a per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 1.5 lb ai/a. PHI 1 day. REI 12 hr. Do not graze or feed foliage to livestock.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for succulent beans, 14 days for dry beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phorate (Thimet 20-G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.
- sulfoxaflo (Transform WG) at 0.75 to 1.0 oz/a. Do not exceed 8.5 oz/a. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed.

## Bean, lima—Seedcorn maggot

*Delia platura*

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Slow emergence and poor stand establishment are signs of seedcorn maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence resulting in increased susceptibility to seedcorn maggot infestation. To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply baker's yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult seedcorn maggot flies as they are attracted to carbon dioxide.

**Management—cultural control**

To reduce attractiveness of the field to egg-laying adults, disc or plow early in the year, incorporating residues from a previous crop and destroying weed growth. Plant under ideal soil and weather conditions to assure rapid seed germination and minimize the seedcorn maggot problem.

One of the most reliable control methods now in general use is to plant seeds that have been treated with an appropriate insecticide in the seed box at planting. Practically all commercially available seed corn is treated with an insecticide to protect the seed from insect pests during storage. However, this treatment is not sufficient to provide field protection against seedcorn maggots. A planter box seed treatment insecticide at planting is recommended.

**Management—chemical control: HOME USE**

- bifenthrin (may be combined with zeta-cypermethrin)
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- chlorpyrifos (Lorsban Advanced)—As a broadcast or T-band treatment prior to planting. Consult label for rates. Do not exceed 0.94 lb ai/a per year.
- phorate (Thimet 20-G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.

## Bean, lima—Slug

**Includes**

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—biological, cultural, tactical**

*See:*

Slug Control

### **Management—chemical control: HOME USE**

- Some formulations are OMRI-listed for organic use.

### **Management—chemical control: COMMERCIAL USE**

- iron phosphate baits at 0.24 to 0.44 lb ai/a. REI: no restrictions. PHI 0 days.
- metaldehyde baits—Do not contaminate edible plant parts. Use as needed, but not more often than once per week.

## **Bean, lima—Spider mite**

### **Includes**

Pacific spider mite (*Tetranychus pacificus*)

Strawberry spider mite (*Tetranychus turkestanii*)

Twospotted spider mite (*Tetranychus urticae*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** There is no precise survey technique for evaluating spider mite infestations. Infestations usually begin on the lower portions of the plants and move upward as mite numbers increase. Evaluating spider mite infestations is most efficient if randomly selected, older, lower leaves are picked and inspected for stippling on the upper surface and webbing, mites, and feeding scars on the lower surface.

### **Management—biological control**

Spider mite populations may be held at very low levels by a number of insect and mite predators, particularly early in the year. Thrips are effective early year predators, feeding primarily on spider mite eggs. Commercial releases of predatory mites are used to control spider mites in greenhouses. In Florida, predatory mites were used to control spider mites in strawberries. Spider mites provide an important food source for predators such as minute pirate and bigeyed bugs.

### **Management—cultural control**

Spider mite problems can be reduced by keeping fields and field margins clean of weed hosts. Spider mite populations may increase more rapidly in areas where dust deposits are heavy. Reducing dust may reduce the spider mite problem. Spider mites are usually less severe in sprinkler-irrigated fields than in furrow-irrigated fields. Excessive nitrogen fertilization also may contribute to population buildup. Minimizing early year insecticide applications, which reduce populations of beneficial insects, will reduce spider mite outbreaks.

### **Management—chemical control: HOME USE**

- azadirachtin (combined with pyrethrins)—Some formulations are OMRI-listed for organic use.

### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) 1.75 to 3.5 fl oz/a. PHI 7 days. REI 12 hr. Do not exceed 10.25 fl oz/a per season. To avoid illegal residues, mix with a surfactant as recommended by the label.
- bifenazate (Acramite 50 WS) at 0.33 to 0.5 lb ai/a. PHI 3 days. One application per season. Do not plant new crops within 30 days of application. Succulent shelled beans only.
- borate complex (Prev-Am) as a 0.4% to 0.8% solution. Spray to complete coverage. PHI 12 hr. REI 12 hr. Retreatment interval 4 days. OMRI-listed for organic use.
- dimethoate (numerous products) at 0.25 to 0.5 lb ai/a. PHI 0 days when harvested mechanically. REI 48 hr. Do not feed treated vines.
- hexythiozox (Onager Optek) at 10 to 24 fl oz/a. PHI 14 days. REI 12 hr. Do not apply more than one application per season. Do not harvest or graze bean vines for hay or forage.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phorate (Thimet 20-G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply at planting. Do not graze or feed to livestock. Toxic to fish and wildlife.

- propargite (Comite) at 1.6 to 2.4 lb ai/a. PHI 14 days. REI 9 days. Do not feed any parts of treated plants to livestock. Do not exceed two applications per year. Dry lima beans only.
- sulfur at 2.25 to 6.75 lb ai/a. REI 24 hr. PHI: consult processor.

## Bean, lima—Wireworm

*Ctenicera* spp. and *Limoni* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (combined with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually combined with zeta-cypermethrin)
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- dichloropropene (Telone II)—Preplant.
- imidacloprid (Gaucho 480F)—Seed treatment. See label for instructions.

## Bean, snap—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Pea aphid (*Acyrtosiphon pisum*)

Potato aphid (*Macrosiphum euphorbiae*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots but avoid sampling only those areas. Also, be sure to look for evidence of biological control, i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen.

*Home gardeners* can often get effective control by washing aphids with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate

- gamma-cyhalothrin
- insecticidal soap (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- malathion
- plant-derived essential oils (peppermint, rosemary, thyme, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per season. Do not exceed 0.3 lb ai/a per acre per year. Bee Hazard: Do not apply this product while bees are actively visiting the treated area. Lower rates allow maximum survival and faster rebound of natural enemies of insect pests.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.087 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a total of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.
- cyantraniliprole (Verimark) at 0.088 to 0.176 lb ai/a at planting. PHI 0 day. REI 4 hr.
- dimethoate (Dimethoate 4E) at 0.25 to 0.5 lb ai/a. PHI 0 days. REI 48 hr. Retreatment interval 14 days. Do not exceed 1.0 lb/a per year. Do not feed treated vines.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not allow livestock to graze treated fields. Do not harvest treated bean vines for livestock forage, fodder or hay.
- flonicamide (Beleaf 50SG) at 0.089 lb ai/a. PHI 7 days. REI 12 hr. Limit 2 treatments. Do not exceed 0.089 lb/a per year.
- flupyradifurone (Sivanto 200 SL) at 0.09 to 0.14 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not graze. Do not exceed 0.06 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.
- imidacloprid (Admire Pro) at 0.043 lb ai/a foliar or 0.25 to 0.375 lb ai/a soil applied. PHI 7 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.13 lb ai/a foliar or 0.375 lb ai/a soil applied per season. Foliar retreatment interval 7 days.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for rate. PHI 0 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20%WDG) at 1 to 2 lb product per acre. PHI 0 days. REI 4 hr. Repeat every 3 to 10 days as needed. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per year. Do not graze livestock in treated areas or harvest vines for forage or hay.
- malathion (Agri Solutions Malathion 5) at 0.61 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not graze or feed foliage to livestock. Limit 2 treatments per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for beans, and 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- phorate (Thimet 20G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. At planting time only. Do not graze or feed to livestock.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Reentry interval 7 days. Do not exceed 0.16 lb ai/a per year. Retreatment interval 7 days.
- sulfoxaflor (Transform) at 0.023 to 0.031 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 14 days. Do not exceed two consecutive applications per crop. Do not exceed 0.266 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a per season.

## Bean, snap—Armyworm and cutworm

### Includes

- Beet armyworm (*Spodoptera exigua*)
- Bertha armyworm (*Mamestra configurata*)
- Western yellowstriped armyworm (*Spodoptera praefica*)
- Black cutworm (*Agrotis ipsilon*)
- Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate
- gamma-cyhalothrin
- insecticidal soap (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- plant essential oils (peppermint, rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

Apply any one of these materials as allowed per label to the soil surface at first sign of cutworm activity. Consult label first as not all product labels are for use on soil. Minimum preharvest interval (PHI) varies with crop.

- alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.0875 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- chlorantraniliprole (Coragen) at 0.065 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Limit 4 treatments. Retreatment interval 3 days. Do not exceed 0.6 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.05 to 0.1 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a total of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- diazinon (Diazinon AG500) at 2 to 4 lb ai/a. REI 3 days. Broadcast just before planting and immediately incorporate into the soil.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not allow livestock to graze treated bean fields. Do not harvest treated bean vines for livestock forage, fodder, or hay.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not graze. Do not exceed 0.06 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 day. REI 4 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early season and 0.12 to 0.25 lb ai/a for mid to late season applications. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/a or four applications per season.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- spinetoram (Radiant SC) at 0.0313 to .0625 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 4 days. Do not exceed 6 applications or 0.219 lb ai/a per season. Follow resistance management procedures on the label. Armyworm only.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 3 days. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed three times in a 30-day period. Do not exceed six applications or 0.45 lb ai/a per crop. Do not feed forage or hay to livestock. Armyworm only. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Some formulations are OMRI-listed for organic use.

See:

Corn, sweet—Armyworm

## Bean, snap—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Beetles damage foliage and bean pods, and larvae chew on roots. If foliage feeding is intense at bean emergence, some growers apply an insecticide, though this is uncommon. Specific treatment thresholds have not been established for foliage feeding on beans in the Pacific Northwest. In Virginia, the following recommendation is made: To prevent cucumber beetle damage to seedlings, treat when one beetle per 10 row ft is found.

The primary beetle damage in snap beans occurs when beetles feed on developing bean pods. In the Pacific Northwest, a sweep net threshold is used to determine if treatment is necessary at early bloom and the “pin bean” stage. Sweep fields with a standard sweep net just prior to first bloom. When one finds an average of two to four beetles per ten arcs of the sweep net, treatment is justified. This is a very conservative threshold.

Be aware of surrounding fields. As grass fields dry down prior to harvest in early July, the first summer generation of western spotted cucumber beetle begins to emerge from the soil. The combination of emerging beetles in a drying landscape can cause sudden surges in beetle pressure in snap bean plantings as beetles migrate into the irrigated plantings from other areas. This is especially a problem starting in late July through August when the first summer generations peak. If sweep net sampling during this period leads to a “no spray” decision, continue to monitor the field through bean harvest.

Experimental use of yellow sticky traps placed in the field just above the crop canopy suggests that, on average, if counts exceed one beetle per trap per day, scout the field one week later. If counts exceed two beetle per trap per day, treatment is justified to protect developing bean pods. A minimum action threshold has not been established for yellow sticky trap counts. If counts fall below one beetle per trap per day, use sweep net sampling and a sweep net action threshold to make a treatment decision. Watch for beetles invading from the surrounding landscape.

### Management—cultural control

In most years, low ebbs occur in the aboveground adult beetle populations after egg laying and before the summer generation emerges. Sometimes, a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Trap-and-spray crops sometimes can be used to draw beetles away from the main crop or intercept incoming beetles at the edge of the field. Trap-cropping is an unproven control method in Oregon.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate
- imidacloprid
- insecticidal soap (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per season. Do not exceed 0.3 lb ai/a per acre per year. Bee Hazard: Do not apply this product while bees are actively visiting the treated area. Lower rates allow maximum survival and faster rebound of natural enemies of insect pests.
- alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/imidacloprid (Brigadier) at 0.0875 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a total of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not allow livestock to graze treated bean fields. Do not harvest treated bean vines for livestock forage, fodder, or hay.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not graze. Do not exceed 0.06 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.

- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.
- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/a. PHI 1 day for beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb/a. PHI 1 day. REI 12 hr. Do not make applications less than 5 days apart. Do not exceed 0.3 lb ai/a per season.

## Bean, snap—Garden symphylan

*Scutigerella immaculata*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. In Oregon, 10 to 20 symphylans per young bean plant were shown to affect plant growth. In general, preplant field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 inch by 6 inch by 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample. Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury. There is some evidence that aggressive tillage, especially roto-tillage suppresses symphylan activity for the same reasons stated above.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with non-host crops has not been studied.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed.
- bifenthrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone II)—Preplant.
- ethoprop (Mocap 15G) at 0.9 to 1.4 lb product/1,000 row ft. Apply in 12- to 15-inch band on the row. See label for adjustments based on specific row spacing. Do not place in contact with seed. Do not apply within 140 ft of aquatic habitat.

## Bean, snap—Grasshopper

Many species

**Pest description, crop damage and life history** Grasshoppers are rarely a problem in snap beans. Grasshoppers eat irregular holes in leaf tissue and can defoliate plants in high numbers, especially when swarming. Damage tends to be greatest on the edges of fields near pasture areas or roadsides. When wild grasses and other plants become dry, grasshoppers migrate to irrigated croplands.

*See:*

Common Pests of Vegetable Crops

### Management—biological control

Predators and parasites of grasshoppers are numerous and at times play an important role in maintaining grasshopper populations at low densities. Unfortunately, under favorable weather conditions, population increases may overwhelm the natural controls, and grasshoppers may reach high densities.

A biological control that has been tested extensively and is commercially available is the protozoan *Nosema locustae* (Nolo Bait). Only registered for use in WA. Nolo Bait has a REI of 4 hr and acts slowly. It may not reduce grasshopper populations to noneconomic numbers the year of application. It may be more effective applied in non-cultivated areas such as borders and pasture where grasshoppers breed. Also, the timing of application is important. Two other organisms, the fungal pathogens *Beauveria bassiana* and *Entomophus grylli*, are being tested as commercial biological control agents.

## Management—cultural control

Disturbance or maturation of crops may cause grasshoppers to disperse. Take care not to cut vegetation or till soil of fields harboring grasshoppers if susceptible crops are being grown nearby. Large blocks of crops with less crop edge tend to be damaged less than smaller blocks.

## Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden as allowed per the label when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate
- gamma-cyhalothrin
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.025 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.0875 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/a. PHI 1 day. REI 4 hr. Limit 4 treatments. Retreatment interval 3 days. do not exceed 0.6 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a total of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.
- dimethoate (Dimethoate 4E) at 0.25 to 0.5 lb ai/a. PHI 0 days. REI 48 hr. Retreatment interval 14 days. Do not exceed 1.0 lb/a per year. Do not feed treated vines.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Apply reduced rates (0.02 to 0.03 lb ai/a) to first and second instar. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not allow livestock to graze treated fields. Do not harvest treated bean vines for livestock forage, fodder, or hay.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not graze. Do not exceed 0.06 lb ai/a per year. Do not graze livestock in treated areas or harvest vines for forage or hay.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per year. Do not graze livestock in treated areas or harvest vines for forage or hay.
- malathion (Agri Solutions Malathion 5) at 0.609 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not graze or feed foliage to livestock.

## Bean, snap—Lygus bug

*Lygus* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Use sweep nets to sample for lygus bugs. In the Pacific Northwest, a suggested treatment threshold is one-half adult or one-half for fourth or fifth instar per sweep..

### Management—biological control

Generalist predators, such as lacewings and damsel bugs, may prey on lygus bug nymphs. Conserve populations of these biological control agents by minimizing applications of broad-spectrum insecticides.

### Management—cultural control

Lygus are likely to move when other food sources become unsuitable. Common weeds that are good hosts of lygus bugs include pigweed and wild radish.

Mowed alfalfa fields nearby are commonly a source of large numbers of lygus bug adults. There are a number of practices to reduce or control the movement of adults from alfalfa into nearby bean fields. These techniques leave uncut, tall alfalfa (which is attractive to lygus bug adults) within or near the cut area.

## Management—chemical control: HOME USE

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate
- gamma-cyhalothrin
- malathion
- plant essential oils (garlic, rosemary, etc.)—Some have demonstrated efficacy. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- bifenthrin (Sniper) at 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- *Chenopodium ambrosioides* (Requiem Prime) at 2 to 4 quarts product per acre. PHI 0 day. REI 4 hr.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a total of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.
- dimethoate (Dimethoate 4E) at 0.5 lb ai/a. PHI 0 days. REI 48 hr. Retreatment interval 14 days. Do not exceed 1.0 lb/a per year. Do not feed treated vines.
- flonicamid (Beleaf 50SG) at 0.089 lb ai/a. PHI 7 days. REI 12 hr. Limit 2 treatments. Do not exceed 0.089 lb/a per year.
- *Isaria fumosorosea* (PFR-97 20%WDG) at 1 to 2 lb product per acre. PHI 0 days. REI 4 hr. Repeat every 3 to 10 days as needed. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per year. Do not graze livestock in treated areas or harvest vines for forage or hay.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 to 3 days for beans, 3 days for feeding vines, 7 days for hay. REI 48 hr. Do not exceed 4.5 lb ai/a per year.
- naled (Dibrom8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Do not exceed 5 treatments per season.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Wait until lygus appear. Do not exceed 0.23 lb ai/a per season.
- phorate (Thimet 20G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 to 72 hr. At planting time only. Do not graze or feed to livestock. Toxic to fish and wildlife.
- sulfoxaflor (Transform WG) at 0.047 to 0.071 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 14 days. Do not exceed two consecutive applications per crop. Do not exceed 0.266 lb ai/a per year.

## Bean, snap—Nitidulid beetle

*Meligethes nigrescens*

**Pest description and crop damage** Nitidulid beetles are rarely a pest of snap beans and rarely require treatment. Adult beetles are small and black. They infest blossoms from mid-July to mid-August. They may cause blossom drop, but control is unnecessary unless populations are very high.

### Management—chemical control: HOME USE

No products are registered for control of this pest.

### Management—chemical control: COMMERCIAL USE

Most insecticides labeled for use on green beans for aphids or other pest of beans reduce nitidulid beetle populations.

## Bean, snap—Pea leaf weevil

*Sitona lineatus*

**Pest description and crop damage** Adults are grayish-brown, slender weevils about 0.19 inch long with a short snout. Wing covers are marked lengthwise by parallel striations. Larvae are small, C-shaped, legless, soft and fleshy, and up to 0.19 inch long. They are milky-white with a brown head.

The pea leaf weevil can be confused easily with the sweet clover weevil. The pea leaf weevil has three light-colored, inconspicuous stripes that extend lengthwise down the thorax and often onto the wing covers. Sweet clover weevil does not have these stripes. The vegetable weevil, *Listroderus diffcilis* is similarly brown with a colored 'V' on the wing covers but its range is presumed to not include the Pacific Northwest.

Seedlings are very susceptible to injury and may be killed if the growing tip is damaged. Damage also may occur later in the year by larvae feeding on the roots of plants, particularly on root nodules. However, older plants—six or more expanded leaves with growing tips intact—are much less likely to suffer significant injury. Adults chew half-circle notches out of leaf margins, and larvae feed on rhizobial root nodules. Host plants include peas, alfalfa, clover, faba beans, and vetch.

**Biology and life history** Adults overwinter under vegetation in old alfalfa and clover fields or in waste areas. Adults begin in mid-March on the coast and in mid-April to early May inland. Eggs are scattered on the soil surface near plants. Eggs hatch in 16 to 18 days, and larvae move into the soil to feed on root nodules. Larvae feed for 20 to 40 days, then pupate in the soil. Adults emerge in July and August and disperse to other legumes. They either feed or summer hibernate (aestivate) before overwintering. In coastal areas, there may be activity during mild weather in the fall and winter. There is one generation each year.

**Pest monitoring** Pea leaf weevils thrive under cool, wet conditions and become less of a problem as the weather warms.

Sweeping can be used for sampling. Cone traps with aggregation pheromones also can be used. Economic damage can occur at densities as low as one-third adult weevil per seedling plant. Growing-point injury of 25% on seedling plants may be considered an action threshold.

#### **Management—cultural control**

Crop rotation and planting beans away from other legumes is useful. Irrigation and proper fertilization may help crops outgrow defoliation.

#### **Management—chemical control: HOME USE**

- bifenthrin (usually as a mix with zeta-cypermethrin)
- carbaryl
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/imidacloprid (Brigadier) at 0.0875 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.

## **Bean, snap—Seedcorn maggot**

*Delia platura*

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Slow emergence and poor stand establishment are signs of seedcorn maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence increase susceptibility to seedcorn maggot infestation. If you are planning to use untreated bean seed in a certified organic planting, sow a handful of seeds several places in the field, water, and flag the sowings one week prior to your field planting date. Inspect the test seeds the day prior to planting the field. If fifty to seventy five percent of the trial seeds are infested with seed corn maggot, consider delaying or abandoning the sowing of untreated seed in the field for this growing season.

#### **Management—cultural control**

To reduce attractiveness of the field to egg-laying adults, disc or plow early in the year, incorporating residues from a previous crop and destroying weed growth. Allow a minimum of three to four weeks between disking in manure and planting bean seeds. Plant under ideal soil and weather conditions to assure rapid seed germination and minimize the seedcorn maggot problem.

One of the most reliable control methods now in general use is to plant seeds that have been treated with an appropriate insecticide. Most commercially available bean seed is treated with an insecticide to protect the seed from insect pests during storage. However, do check the label. Remember, seed treatment alone may not be sufficient to provide field protection against seedcorn maggots. A planter box seed treatment insecticide at planting is recommended.

#### **Management—chemical control: HOME USE**

- bifenthrin
- gamma-cyhalothrin
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- phorate (Thimet 20G)—Do not exceed 1.5 lb ai/a. PHI 60 days. REI 48 to 72 hr. At planting time only. Do not graze or feed to livestock. Toxic to fish and wildlife.

*See:*

Corn, sweet—Seedcorn maggot

## Bean, snap—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron (ferric) phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Follow barrier restrictions on labels. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

### Management—chemical control: COMMERCIAL USE

- iron phosphate baits at 0.24 to 0.44 lb ai/a. REI—4 hrs. PHI 0 days.
- metaldehyde baits. Do not contaminate edible plant parts. Use as needed, but not more often than once per week.

## Bean, snap—Spider mite

### Includes

Pacific spider mite (*Tetranychus pacificus*)

Strawberry spider mite (*Tetranychus turkestanii*)

Twospotted spider mite (*Tetranychus urticae*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** There is no precise survey technique for evaluating spider mite infestations in snap beans. Infestations usually begin on the lower portions of the plants and move upward as mite numbers increase. Evaluating spider mite infestations is most efficient if older, lower leaves are selected at random and inspected for stippling on the upper surface and webbing, mites, and feeding scars on the lower leaf surface.

### Management—biological control

Spider mite populations may be held at very low levels by a number of insect and mite predators, particularly early in the year. Thrips feed on spider mite eggs; they are effective early year predators. Predatory mites are used to control spider mites in strawberries and in greenhouses. The impact of releasing commercially produced predatory mites in snap beans is untested. Spider mites provide an important food source for predators such as minute pirate and bigeyed bugs.

### Management—cultural control

Minimizing early year insecticide applications, which tend to reduce populations of beneficial insects, will reduce spider mite outbreaks. Spider mite problems can be reduced by keeping fields and field margins clean of weed hosts. Spider mite populations increase more rapidly in areas where dust deposits are heavy. Reducing dust may reduce the spider mite problem. Excessive nitrogen fertilization may contribute to population buildup.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- insecticidal soap—Complete coverage of upper and lower leaf surfaces important. More than one application may be required. Some formulations are OMRI-listed for organic use.
- plant essential oils (such as cottonseed, clove and garlic oils)—Some formulations are OMRI-listed for organic use.

- sulfur (usually as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) at 0.019 lb ai/a. PHI 7 days. REI 12 hr. Non-ionic surfactant required. Do not exceed 0.056 lb ai/a per season. Limit 2 treatments.
- acequinocyl (Kanemite 15SC) at 0.3 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per season.
- bifenthrin (Sniper) at 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- bifenazate (Acramite 50WS) at 0.5 to 0.75 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed two treatments per season.
- dimethoate (Dimethoate 400 EC) at 0.5 lb ai/a. PHI 0 days if mechanically harvested. REI 48 hr. Retreatment interval 14 days. Do not exceed 1.0 lb/a per year. Do not feed vines or hay.
- fenpyroximate (Miteus) at 0.105 lb ai/a. PHI 1 day. REI 12 hr. Limit 2 treatments. Do not exceed 0.21 lb ai/a per season. Retreatment interval 14 days.
- hexythiazox (Onager) at 0.078 to 0.188 lb ai/a. PHI 14 days. REI 12 hr. One treatment per year. Do not harvest or graze bean vine forage or hay.
- *Isaria fumosorosea* (PFR-97 20%WDG) at 1 to 2 lb product per acre. PHI 0 days. REI 4 hr. Repeat every 3 to 10 days as needed. OMRI-listed for organic use.
- naled (Dibrom 8) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Do not exceed 5 treatments per season.
- phorate (Thimet 20G) at 1.5 lb ai/a. PHI 60 days for forage. REI 48 to 72 hr. At planting time only. Do not graze or feed to livestock. Extremely toxic to fish and wildlife.
- sulfur at 2.25 to 6.75 lb ai/a. PHI 0 days. REI 24 hr. Some formulations are OMRI-listed for organic use.

## **Bean, snap—Stink bug and plant bug**

Many species in two families:

Pentatomidae (stink bugs)

Miridae (plant bugs)

**Pest description and crop damage** Stink bugs and plant bugs are rarely a problem in snap beans and rarely require treatment. Adult stink bugs have shield-shaped bodies that are about 0.5 inch long and either brown or green with red, pink, or yellow markings. Barrel-shaped eggs are laid in clusters of about 14 eggs on leaves of broadleaf plants. Nymphs resemble adults in shape. Plant bug adults are black with a white stripe along the outer margin of the wings. The head is broader than the shoulders (prothorax) and the eyes are widely spaced on stalks. Nymphs are wingless, light gray, with mottled markings. Both stink bugs and plant bugs feed on blossoms and beans with piercing, sucking mouthparts. Damage is similar to that caused by lygus bugs. Outbreaks appear to be cyclical.

**Biology and life history** Stink bugs overwinter as adults under leaves and trash, in the crowns of plants, in clumps of grass, or in other protected places such as box piles and buildings. After mating, if suitable host plants are not present, adults travel to find suitable host plants. There are one to three overlapping generations each year. Adults seek overwintering sites before fall frosts. Plant bugs complete one generation each year.

**Pest monitoring** Adult bugs often hide when approached, making them difficult to see. When feeding, stink bugs leave small drops of brown excrement. Begin monitoring after the weather has warmed up in March and look for overwintering bugs feeding on curly dock, common mullein, or other broadleaf plants.

#### **Management—cultural control**

Clean cultivation in fall discourages overwintering bugs.

#### **Management—chemical control: HOME USE**

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- carbaryl
- esfenvalerate
- gamma-cyhalothrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.266 lb/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed a to-

tal of 31.0 fl oz of Besiege or 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Do not graze livestock or harvest vines for forage or hay.

- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not graze. Do not exceed 0.06 lb ai/a per season. Do not graze livestock in treated areas or harvest vines for forage or hay.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per year. Do not graze livestock in treated areas or harvest vines for forage or hay.
- naled (Dibrom 8) at 1.4 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Do not exceed 5 treatments per season.
- sulfoxaflor (Transform WG) at 0.047 to 0.071 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 14 days. Do not exceed two consecutive applications per crop. Do not exceed 0.266 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb/a. PHI 1 day. REI 12 hr. Do not make applications less than 5 days apart. Do not exceed 0.3 lb ai/a per season.

## Bean, snap—Wireworm

*Ctenicera* spp. and *Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 3-9 days depending on harvesting method. REI 5 days. Do not exceed 0.2 lb ai/a per season. Only registered for use in WA.
- chloropicrin (Telone II)—Preplant.
- diazinon (Diazinon AG500) at 3 to 4 lb ai/a. REI 3 days. Broadcast just before planting and immediately incorporate into the top 4 to 8 inches of soil.
- imidacloprid (Gaucho 600F)—Seed treatment. See label for instructions.

## Beet, table—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Pea aphid (*Acyrtosiphon pisum*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description and crop damage** The green peach aphid is slender, dark green to yellow, and has no waxy bloom. It is primarily an early year pest. Green peach aphid infestations may result in wilting.

The potato aphid has both a pink and green form. It is a larger aphid. High potato aphid populations can distort leaves and stems, stunt plants, and cause necrotic spots on leaves. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit. The bean aphid is dark olive green to black with light-color legs. It is usually more of an early year pest. The pea aphid, common on peas, is a relatively large, green, somewhat shiny species.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedlings emerge. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. Row covers can be used to protect high value crops.

*Home gardeners* can often get effective control by washing aphids with a strong stream of water.

Research in California has shown that silver- or aluminum-colored mulches repel winged aphids. These may reduce the rate of colonization by winged aphids significantly and delay the buildup of damaging numbers of aphids by 4 to 6 weeks.

### Management—chemical control: HOME USE

Apply control measures when aphid first appear, and repeat applications at 8 to 10 day intervals as needed.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap (may require several applications)—Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (peppermint, rosemary, etc.)—Some have demonstrated efficacy. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season. Leaves cannot be used for food or feed.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/a per season. Leaves cannot be used for food or feed.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per year.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season. Tops not for human or animal consumption.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.13 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season. Do not harvest leaves for livestock feed.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil; 0.044 lb ai/a foliar. PHI 7 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season. Retreatment interval 5 days, foliar. Do not exceed 1 treatment per season, soil.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications.
- sulfoxaflo (Transform WG) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 24 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.125 lb ai/a per season. Retreatment interval 7 days.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a at plant soil application. REI 12 hr. Do not exceed 0.188 lb ai/a per season.

## Beet, table—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

Western yellowstriped armyworm (*Spodoptera praefica*)

### Pest description, crop damage and life history

*See:*

## Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- plant essential oils (peppermint, rosemary, etc.)—Some have demonstrated efficacy. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop/alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season. Leaves cannot be used for food or feed.

- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin WG) at 0.12 to 1.5 lb ai/a. PHI 0 days. REI 4 hr. Armyworms only. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per year.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season. Leaves cannot be used for food or feed.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 5 bait) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 6 lb ai/a per crop. Retreatment interval 7 days.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments per season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season. Tops not for human or animal consumption.
- diazinon (Diazinon AG500) at 1.7 lb ai/a at preplant broadcast and incorporate. REI 3 days. Toxic to birds, fish and other wildlife. Only registered for use in OR
- indoxacarb (Avaunt) at 0.065 to 0.11 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 3 days. Do not use adjuvants. Do not exceed 0.44 lb ai/a per crop. Do not use adjuvant. Limit 4 treatments per year.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 0 days for roots, and 10 days for tops. REI 48 hr. Do not exceed 3.6 lb ai/a or eight applications per year.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season. Retreatment interval 14 days.
- spinetoram (Radiant SC) at 0.047 to 0.0625 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Limit 4 applications per crop. Do not exceed 0.25 lb ai/a per season.
- spinosad (Success, Entrust SC) at 0.07 to 0.156 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 7 days. Treat eggs at hatch and small larvae. Do not exceed 4 applications or 0.33 lb ai/a per crop. Armyworm only. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Entrust SC is OMRI-listed for organic use.
- zeta cypermethrin (Mustang) at 0.016 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.3 lb ai/a per season. Tops and roots cannot be used for food or feed.

*See:*

Corn, sweet—Armyworm

Corn, sweet—Cutworm

## Beet, table—Blister beetle

*Epicauta* spp.

**Pest description and crop damage** Adults are slender, oblong beetles with a relatively large head and an extenuated neck, often with yellow stripes in some form. Eggs are oblong and yellow. Larvae usually are found in several stages, and all stages have three upper body legs. The pupa is a stage

of darkening, starting with the eyes. Blister beetles are mostly foliage feeders, but they are not considered a major pest of vegetable crops. While feeding, they leave behind a distinctive black stringy substance. Blister beetles tend to stay in weedy areas, especially where there is an abundance of grasshopper eggs, which the larvae consume. Only the adult stage causes crop damage. They tend to move in swarms and can cause a great deal of localized defoliation. They do not generally stay in one area for very long. The beetles get their name from a toxin they contain called cantharidin. Even dead insects can cause blisters if handled. The most serious damage comes from hay that has been treated for blister beetle populations. The beetles are bailed in the hay and eaten by horses and other animals.

**Biology and life history** Blister beetles pass the winter in a pseudopupa stage and then go through a final molt in the spring. After a short period of activity, the larva enters the true pupal stage, and adults emerge in midsummer. Adults feed on the vegetation of a variety of plants. Eggs are deposited in clusters of 100 to 200 in cavities in the soil and normally hatch in 2 weeks.

Larvae frequently feed on grasshopper eggs. They spend about 43 days in this stage. There is one generation each year.

**Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins—Some formulations are OMRI-listed for organic use.
- carbaryl
- malathion
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year.

**Note:** Blister beetles are killed easily with insecticides.

## Beet, table—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Beet seedlings may be susceptible to beetle damage at emergence. Specific treatment thresholds have not been established for beetle foliage feeding on beet tops in Oregon. In Virginia, to prevent cucumber beetle damage to seedlings, the recommendation is to treat when one beetle per 10 row ft is found.

Be aware of surrounding fields. As grass fields dry down prior to harvest, and when harvested vegetable crops are disked into the soil, sudden surges in beetle pressure occur as beetles migrate in from other areas.

**Management—cultural control**

In most years, low ebbs occur in the aboveground adult beetle populations after egg laying and before the summer generation emerges. Sometimes, a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Trap-and-spray crops sometimes can be used to draw beetles away from the main crop or intercept incoming beetles at the edge of the field. Trap-cropping is an unproven control method in Oregon.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- malathion
- pyrethrins (may be combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season. Leaves cannot be used for food or feed.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/a per season. Leaves cannot be used for food or feed.
- methomyl (Lannate SP) at 0.45 lb ai/a. PHI 0 days for roots and 10 days for tops. REI 48 hr. Do not exceed eight applications or 3.6 lb ai/a per year.
- zeta cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.3 lb ai/a per season. Tops and roots cannot be used for food or feed.

## Beet, table—Flea beetle

Includes *Epitrix* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological control

- nematodes—Soil must be warmer than 53°F (larvae only).

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- malathion
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season. Leaves cannot be used for food or feed.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per year.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil; 0.044 lb ai/a foliar. PHI 7 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.44 lb ai/a soil or 0.13 lb ai/a foliar per season. Retreatment interval 5 days, foliar. Do not exceed 1 treatment per season, soil.
- imidacloprid (Prey 1.6) at 0.043 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a per season. Limit 3 treatments per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. REI 12 hr. PHI 7 days. Do not exceed 0.125 lb ai/a per year. Retreatment interval 7 days.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a at plant soil application. REI 12 hr. Do not exceed 0.188 lb ai/a per season.
- zeta cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.3 lb ai/a per season. Tops and roots cannot be used for food or feed.

## Beet, table—Garden symphylan

*Scutigera immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** We do not have a specific threshold for symphylan in table beets for Oregon conditions. In general, field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury. Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with non-host crops has not been studied.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

### **Management—chemical control: COMMERCIAL USE**

Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone.

- chloropicrin (Telone II)—Preplant only.

Preplant application of diazinon for wireworm control may suppress symphylans.

## **Beet, table—Leafminer**

### **Includes**

Beet leafminer (*Pegomya betae*)

Spinach leafminer (*Pegomya hyoscyami*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long, stiff bristles. Larvae are nearly translucent white or yellow and about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups.

Adult leafminers may stunt seedlings by attacking the cotyledons in seeds. Larvae mine between upper and lower leaf surfaces, creating winding, whitish tunnels that initially are narrow, but then widen as the larvae grow. Excessive mining renders leaves unmarketable, reduces photosynthetic capacity, and provides easy access for disease organisms.

**Biology and life history** Leafminers overwinter as pupae in the soil. Adults emerge in late May, mate, and females lay eggs on the undersides of beet and chard leaves or on lambsquarters. The eggs hatch in about 4 days, and the small maggots eat into the leaf. There may be several maggots in a leaf. When mature, larvae fall to the ground and pupate just under the soil surface. Adults emerge in 10 to 25 days and begin laying eggs for another generation. There are at least three generations each year.

**Pest monitoring** Regularly check young seedlings for leaf mines. Most mines occur on cotyledons and the first true leaves. Some mines are more visible when seen from the underside of the leaf. If leafminer populations build to high levels when seedlings have four to five leaves, a chemical treatment may be necessary. Treat if you find more than an average of one mine per leaf in your overall field sample. To be effective, sprays must be applied to the larval stage.

### **Management—biological control**

Natural enemies, especially parasitic wasps, commonly reduce populations of leafminers, unless they are killed off by insecticides applied to control other pests. To avoid killing beneficials, choose selective pesticides for treating other pests, whenever possible. Other parasites attack leafminers, but because leafminers feed within the leaf, they generally are protected from most predators.

### **Management—cultural control**

Liriomyza leafminers attack a wide variety of vegetable crops. Where possible, avoid planting next to infested fields, especially those near harvest. Postharvest disking of fields destroys pupae and reduces migration of adult flies into susceptible fields. Apply floating row covers to the plants during April to May. Controlling infested weeds, especially lambsquarter, may help in control. Rotate crops from one year to the next so they are not planted in previously infested areas.

### **Management—chemical control: HOME USE**

No spray is advised on beets grown for leaf tops.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (peppermint, rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

- spinosad (Success) at 0.062 to 0.156 lb ai/a. PHI 3 days. REI 4 hr. Treat eggs at hatch and small larvae. Retreatment interval 7 days. Do not exceed 4 applications or 0.33 lb ai/a per crop. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. A penetrating surfactant or oil is critical for optimal control of leafminers. Consult the adjuvant section on spinosad labels. Some formulations are OMRI-listed for organic use.

## **Beet, table—Slug**

### **Includes**

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—biological, cultural, tactical**

*See:*

Slug Control

### **Management—chemical control: HOME USE**

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron (ferric) phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

### **Management—chemical control: COMMERCIAL USE**

- iron phosphate/spinosad (Bug-N-Sluggo) baits at 20-44 lb/a. PHI 3 days. Retreatment interval 7 days. Limit 4 applications. REI 4 hr.

## **Beet, table—Spider mite**

### **Includes**

Pacific spider mite (*Tetranychus pacificus*)

Strawberry spider mite (*Tetranychus turkestanii*)

Twospotted spider mite (*Tetranychus urticae*)

### **Pest description and crop damage**

*See:*

Common Pests of Vegetable Crops

### **Biology and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- horticultural oil—Some formulations OMRI-listed for organic use.
- insecticidal soap (often as a mix with sulfur)—Some formulations OMRI-listed for organic use.
- plant essential oils—Some formulations are OMRI-listed for organic use.
- sulfur (often as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

### **Management—chemical control: COMMERCIAL USE**

- abamectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.43 lb ai/a per year.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/a per season. Leaves cannot be used for food or feed.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per year.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* (Requiem Prime) at 2 to 4 qt product per acre. PHI 0 day. REI 4 hr.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- sulfur at 4 lb ai/a. REI 24 hr. Retreat as necessary. Some formulations are OMRI-listed for organic use.

## Beet, table—Wireworm

*Ctenicera* spp. and *Limonius* spp.

### Pest description, crop damage, biology and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone II)—Apply preplant only.
- diazinon (Diazinon AG500) at 3 to 4 lb ai/a preplant broadcast and incorporate. REI 3 days. See label for chemigation instructions. Toxic to birds, fish and other wildlife. Only registered for use in OR.

## Broccoli, Brussels sprout, cabbage, cauliflower—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Green peach aphid (*Myzus persicae*)

Turnip aphid (*Hyadaphis erysimi*)

**Pest description and crop damage** The cabbage aphid is green-gray with a waxy bloom. It forms dense colonies that cannot be removed before processing or marketing. The cabbage aphid is the primary contaminant for harvested broccoli, sprout, cabbage, and cauliflower.

The turnip aphid looks very much like the cabbage aphid but lacks the waxy bloom. It tends to be more evenly distributed over plants.

The green peach aphid is slender, dark green to yellow, and lacks a waxy bloom. It is primarily an early year pest. Green peach aphid infestations may result in wilting. The green peach aphid rarely contaminates harvested broccoli, sprout, cabbage, and cauliflower.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not in a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. *Home gardeners* can often get effective control by washing aphids with a strong stream of water.

### Management—chemical control: HOME USE

Apply when aphid first appear; repeat at 8- to 10-day intervals as allowed per label.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)

- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- horticultural oil —Some formulations OMRI-listed for organic use.
- imidacloprid
- lambda-cyhalothrin
- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion
- permethrin
- plant essential oils and extracts (such as clove, garlic and rosemary oils)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acephate (Acephate 90WDG) at 0.5 to 1.0 lb ai/A. PHI 14 days. REI 24 hr. Do not exceed 2 lb ai/A per season. Retreatment interval 7 days. Do not feed trimmings to livestock or allow animals to graze in treated areas. Brussels sprout and cauliflower only.
- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.375 lb ai/A per year. Do not exceed five applications per season. Retreatment interval 7 days.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.030 to 0.048 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. REI 4 hr. PHI 0 days. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Sniper, Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not exceed five applications after bloom. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed a total of 0.172 lb ai of thiamethoxam products or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar or at 0.15 to 0.2 lb ai/A soil applied. PHI 7 days foliar, 21 days soil. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Foliar retreatment interval 10 days.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- dimethoate (Dimethoate 400) at 0.25 to 0.5 lb ai/A. PHI 7 days broccoli and cauliflower; 10 days Brussels sprout. REI 48 hr; 72 hr where rainfall is below 25 inches per year. Do not exceed 1.5 lb ai/A per season. Retreatment interval 7 days. Not registered for use on cabbage.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/A as foliar spray, at 0.23 to 0.27 lb ai/A as soil treatment. PHI 1 day for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil per season. Suppression only.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/A per season. Limit 3 applications per year. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.091 to 0.157 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per season. Limit 3 treatments per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/A soil application or at 0.046 lb ai/A foliar. PHI foliar 7 days; soil 21 days. REI 12 hr. Do not exceed 0.38 lb ai/A soil or 0.23 lb ai/A foliar per year. Retreatment interval 5 days.
- imidacloprid (Prey 1.6) at 0.049 lb ai/A. PHI 7 days. REI 12 hr. Do not use more than 0.23 lb ai/A per year. Retreatment interval 5 days.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for rate. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- malathion (Malathion 8 Flowable) at 1.25 lb ai/A. PHI 2 days for broccoli, Brussels sprout, cauliflower; 7 days for cabbage. REI 48 hr. Retreatment interval 7 days. Limit 2 treatments per year.
- naled (Dibrom 8) at 0.9 lb ai/A. PHI 1 day. REI 48 hr. Do not exceed 9.4 lb ai/A per year. Retreatment interval 7 days. Limit 5 applications.
- pymetrozine (Fulfill) at 0.086 lb ai/A. PHI 7 days. REI 12 hr. A penetrative adjuvant may improve control. Retreatment interval 7 days. Do

not exceed 0.17 lb ai/A per season. Not registered for use in Oregon on this crop.

- pyriproxyfen (PQZ Insecticide) at 0.035 to 0.047 lb ai/A. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/A per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/A. PHI 1 day. REI 24 hr. Reentry interval 7 days. Do not exceed 3 applications totaling 10 fl oz per acre per year.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/A. PHI 3 days. REI 12 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/A per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with drip irrigation.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per year.

## Broccoli, Brussels sprout, cabbage, cauliflower—Armyworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** The bertha armyworm is considered a “climbing cutworm” because it spends little time near the ground. It can be easy to miss while scouting, because though eggs and young instars tend to be clustered, later in the year they disperse actively. Larvae also tend to drop quickly from plants when disturbed, avoiding detection. Populations can explode due to an influx of overlapping generations of migrating moths along with overwintering populations.

Pheromone traps are useful for determining when major flights occur but not for predicting damage. A 5-minute timed search is useful in determining the need for treatment. On average, if one or more larvae or egg masses are found in 5 minutes, treatments may be justified. In those rare instances when control measures are required, the beet armyworm is more difficult to control than the western yellowstriped armyworm. Insecticide applications are most effective if applied against small larvae.

### Management—biological control

Common natural enemies of armyworms include several braconid and ichneumonid wasps, many general predators including assassin bugs, damsel bugs, and spiders, and a nuclear polyhedrosis virus, reported to have brought about excellent late year control in Canada. None of these natural enemies can be counted upon to achieve adequate control in any given year.

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR
- lambda-cyhalothrin
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for

organic use.

- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not listed for use in OR.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/A at planting in furrow or broadcast to soil surface. Do not exceed 0.1 lb ai/A per season at plant application. Refer to label instructions.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 5 Bait) at 1 to 2 lb ai/A foliar or 2 lb ai/A as bait. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/A per crop. Limit 3 bait treatments per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A at planting; via drip irrigation; as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for drip. Do not exceed 0.2 lb ai/A per season. Consult label for details.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. OMRI-listed for organic use. Only registered for use in WA.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 7 days. Limit 3 treatments per crop. Do not exceed 0.22 lb ai/A per year. Some restrictions on application timing. Not registered for use in WA.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season.
- cypermethrin (Holster) at 0.075 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A (28.8 oz/A) per season. Do not allow livestock to graze in treated areas.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/A. REI 24 hr. PHI 7 days. Do not exceed 0.8 lb ai/A per season.
- flubendiamide/buprofezin (Vetiva) at 0.21 to 0.42 lb ai/A. PHI 1 day. REI 12 hr. Minimum application interval 7 days. Limit 2 treatments. Do not exceed 0.83 lb ai/A per year. Product Not registered for use in OR.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season. Effective on first and second instar. Toxic to bees.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A. PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 3 days. REI 12 hr. Use of wetting agent recommended. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application; at 0.12 to 0.16 lb ai/A for mid- to late-season application or heavy infestation. PHI 1 day. REI 4 hr. Adding adjuvant improves performance. Do not exceed 1.0 lb ai/A per season.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per season.
- permethrin (ermethrin Cutworm bait) at 0.05 to 0.1 lb ai/A (cauliflower and Brussels sprout) and 0.01 to 0.2 lb ai/A (broccoli and cabbage). PHI 1 day. REI 12 hr. Do not exceed 0.8 lb ai/A on broccoli, and 0.4 lb ai/A on cauliflower, Brussels sprout and cabbage per season.
- permethrin (Permethrin) at 0.05 to 0.2 lb ai/A broccoli, cauliflower & Brussels sprout or 0.1 to 0.2 lb ai/A for cabbage. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.8 lb ai/A on broccoli or 0.4 lb ai/A on Brussels sprouts, cabbage and cauliflower per season.

- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.06 to 0.156 lb ai/A. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed three times in a 30-day period. Do not exceed 0.45 lb ai/A or six applications per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early year; 0.12 lb ai/A mid to late year. PHI 7 days. REI 4 hr. Do not exceed 1.8 lb ai/A or 15 applications per year. Retreatment interval 10 to 14 days. Use of a surfactant is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Cabbage maggot

*Delia brassicae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate.

If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments would be of little value.

Sticky traps and sweep nets also can be used to monitor the adult fly.

### Management—biological control

Rove beetles prey on maggot eggs and young larvae. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp, *Trybliographa rapae*, lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

### Management—cultural control

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seedrow. It is believed that adult flies can locate the seed row for egg-laying by honing in on the higher moisture levels created when the soil is overturned for planting.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops unless sufficient time has passed for the residue to dry or decompose completely.

Row covers using various fabrics, such as Remay, have proven very effective in preventing egg laying around the base of the plants. Row covers are ineffective if the crop is grown on land that has been previously infested heavily by the maggot, since overwintering flies will have emerged under the row covers.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

Every year, in areas where cabbage maggot causes economic injury, treat spring planted or transplanted crops with a band of insecticide at the base of the plant at the time of planting or transplanting. Control of adult flies is generally not recommended. Later sprays cannot be relied upon to control the pest effectively. Treat seedbeds for transplanted crops with an insecticide.

### Transplant application

- chlorantraniliprole (Coragen 2ee) at 5 fl oz per acre as a transplant water treatment. PHI 3 days. REI 4 hr. Do not exceed 0.2 lb ai/A chlorantraniliprole per year. Do not exceed 0.132 lb ai/A of Coragen per crop by any treatment combination.
- diazinon (Diazinon 50W) at 0.5 to 1 lb ai per 200 gallons of transplant water. Apply in transplant water as a drench application when 200-300 gals of water are used per acre. Apply labeled rate by tractor-mounted sprayer equipped with drop nozzles to direct spray to the base of the plant. Note: Transplant water treatments may result in stand reduction due to plant stress at time of transplanting. Refer to label.
- spinetoram (Radiant SC)—Consult label for rates according to row spacing. Suppression only.
- At plant or post plant soil application
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 5 days. Retreatment interval 7 days. Do not exceed 0.5 lb ai/A per season. Refer to label. Empower 2 no longer registered for use in OR.

- spinetoram (Radiant SC)—Under high root maggot pressure direct the spray in a narrow band at the base of the plants. Consult label for rates.
- Preplant incorporation application for direct seeded or transplanted crop
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/A at planting in furrow or broadcast to soil surface. Do not exceed 0.1 lb ai/A per season at plant application. Refer label instructions.
- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/A in-furrow with seed or transplant. REI 12 hr.
- diazinon (Diazinon 50W) at 2 to 3 lb ai/A (minimum 10 gal/A). Broadcast just before planting and immediately incorporate into the top 3-4 inches of soil.
- spinetoram (Radiant SC)—Consult label for rates according to row spacing. Suppression only.

## Broccoli, Brussels sprout, cabbage, cauliflower—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Pheromone traps can be used to monitor for cutworms. Moth counts in excess of two black cutworm moths per trap per day indicate significant egg laying pressure. It is useful to check moth counts prior to making a pesticide application decision at planting.

If the cutworm population is reducing the plant stand, treat during the seedling stage. Frequently, the damage is most serious at the edges of a field, but stand loss can occur in a spotty pattern throughout the field.

Usually, it is necessary to dig in the soil to find black cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved. Larvae normally hide under debris on the soil surface during the day, but are active, voracious feeders at night.

Since extensive damage may occur in a short period of time, inspect plant beds and newly set plants frequently. In North Carolina, an economic threshold of 5% injured plants has been established for cutworms infesting newly set or young plants (within 3 weeks after transplanting). In Ontario, Canada, the guideline for black cutworm on many seedling vegetables is also 5% plants infested.

### Management—biological control

Cutworms are attacked by a number of predators, parasites, and diseases. Many of these natural control agents are not effective on pale western and black cutworms because of their subterranean nature. It is not known if any of these natural enemies can control cutworm populations, but their presence should be noted.

### Management—cultural control

Cutworms are most injurious in fields with high plant residue. Historically, cutworms are a problem in early, spring-seeded seedling fields. Tillage prior to seeding is an effective means of preventing cutworm damage. A thorough harrowing may provide adequate control when cutworms are feeding actively in established fields.

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials at first sign of cutworm activity according to labeled instruction. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not listed for home use in OR.
- lambda-cyhalothrin
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for

organic use.

- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.030 to 0.048 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- bifenthrin (Capture LFR) 0.04 to 0.08 lb ai/A at planting in furrow or broadcast to soil surface. Do not exceed 0.1 lb ai/A per season as an at plant application.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Armyworm only. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 5 days. Retreatment interval 7 days. Do not exceed 0.5 lb ai/A per season. Not registered for use in OR.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A as granule. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 3 treatments per year. Toxic in aquatic habitats.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. OMRI-listed for organic use. Not registered for use in OR.
- cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season. Toxic to bees.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/A (10 gal min per A). Broadcast just before planting and immediately incorporate. REI 4 days.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- flubendiamide/buprofezin (Vetica) at 0.21 to 0.42 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments. Do not exceed 0.84 lb ai/A per year. Not registered for use in OR.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- methomyl (Lannate SP) at 0.45 lb ai/A. PHI 1 day for cabbage; 3 days for others. REI 48 hr. Do not exceed 7.2 lb ai/A for cabbage and cauliflower and 5.4 lb ai/A for Brussels sprout.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/A for cabbage only. PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/A on cabbage per year.
- permethrin (Permethrin Cutworm Bait) at 0.05 to 0.1 lb ai/A (cauliflower and Brussels sprout) and 0.01 to 0.2 lb ai/A (broccoli and cabbage). PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/A on cabbage, cauliflower & Brussels sprout and 0.8 lb ai/A broccoli per season.
- tolfenpyrad (Torac) at 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Diamondback moth

*Plutella xylostella*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moth as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

In Minnesota, action thresholds for diamondback moth in cabbage are: Where diamondback moth is the primary insect pest (usually early-year), before cupping, treat with *Bacillus thuringiensis* (*Bt*) if 50% of plants are infested with five or more larvae each. After cupping, treat if 10% of plants are infested with one or more larvae each.

An action threshold for diamondback contamination of broccoli heads has not been established in Oregon. If fourth-instar larvae are on leaves when the broccoli head elongates, an early insecticide spray is justified to prevent larvae from moving up into the developing broccoli heads and forming their pupae. Preharvest clean-up sprays do not remove pupae from broccoli heads once they are formed.

#### **Management—biological control**

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, consider the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (*Bt*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- acephate (Acephate 90WDG) at 1.0 lb ai/A. PHI 14 days. REI 24 hr. Do not exceed 2 lb ai/A per season. Retreatment interval 7 days. Do not feed trimmings to livestock or allow animals to graze in treated areas. Brussels sprout and cauliflower only.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.030 to 0.048 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A (larvae only). PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Retreatment interval 7 days. Do not exceed 5 applications after bloom.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- borate complex (Prev-AM Ultra) at 0.4% solution. REI 24 hr. Spray to complete retreatment interval coverage. 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A at planting; via drip irrigation; as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for drip. Do not exceed 0.2 lb ai/A per season. Consult label for details.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. OMRI-listed for organic use. Product Not registered for use in OR.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Best to rotate with products with different IREC numbers to reduce resistance development. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 5 days. Limit 3 treatments per crop. Do

not exceed 0.16 lb ai/A per year. Some restrictions on application timing. Product Not registered for use in WA.

- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A (larvae only). PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A per season. Do not allow livestock to graze in treated areas.
- flubendiamide/buprofezin (Vetiva) at 0.21 to 0.41 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments. Do not exceed 0.83 lb ai/A per year. Not registered for use in OR.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season. Toxic to bees.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 3 days. REI 12 hr. Use of wetting agent recommended. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per year. Insects stop feeding soon after application, but 3 to 4 days are required for maximum effect on lepidoptera larvae.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/A. PHI 3 days for Brussels sprout, broccoli, and cauliflower, 1 day for cabbage. REI 48 hr. Do not annually exceed 5.4 lb ai/A for Brussels sprout, 6.3 lb ai/A for broccoli, or 7.2 lb ai/A for cabbage and cauliflower. Add a surfactant to improve coverage.
- naled (Dibrom 8) at 0.94 lb ai/A. PHI 1 day. REI 48 hr. Do not exceed 9.4 lb ai/A per year. Retreatment interval 7 days. Limit 5 applications.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.156 lb ai/A per season.
- permethrin (Permethrin) at 0.05 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.8 lb ai/A per year on broccoli or 0.4 lb ai/A per year on cauliflower, cabbage and Brussels sprout.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.023 to 0.062 lb ai/A. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed three times in a 30-day period or six applications or 0.45 lb ai/A per crop. Entrust SC is OMRI-listed for organic use.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Flea beetle

**Includes** cabbage flea beetle (*Phyllotreta cruciferae*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours. Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 ft of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

### Management—biological control

- nematodes (larvae only)—Soil must be warmer than 53°F (larvae only).

### Management—cultural control

“Trap crops,” such as radish or daikon, may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high value crops. Flea beetles can be vacuumed off foliage, but this practice must be repeated frequently. Reinvasion of plants can be rapid.

### Management—chemical control: HOME USE

- acetamiprid
- azarirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.

- gamma-cyhalothrin
- imidacloprid
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not listed for homeuse in OR.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar or at 0.15 to 0.2 lb ai/A soil applied. PHI 7 days foliar, 21 days soil. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Foliar retreatment interval 7 days.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 5 days. Limit 3 treatments per crop. Do not exceed 0.22 lb ai/A per year. Some restrictions on application timing. Product not registered for use in WA.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A (larvae only). PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. OMRI-listed for organic use. Product not registered for use in OR.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/A as foliar spray, at 0.23 to 0.27 lb ai/A as soil treatment. PHI 1 day for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season.
- imidacloprid (Admire Pro) at 0.047 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.23 lb ai/A per year. Retreatment interval 5 days.
- imidacloprid (Prey) at 0.05 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year. Retreatment interval 5 days.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- malathion (Malathion 8 Flowerable) at 1.25 lb ai/A. PHI 2 days broccoli, Brussels sprout, cauliflower; 7 days for cabbage. REI 48 hr. Retreatment interval 7 days. Limit 2 treatments per year.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/A per year. Cabbage only.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Garden symphylan

*Scutigera immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** We do not have a specific threshold for symphylan in broccoli, Brussels sprout, cabbage, or cauliflower for Oregon conditions. In general, field evaluation for symphylans involves grid sampling at one-acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with non-host crops has not been established in Oregon.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone.

- chloropicrin (Telone II)—Preplant.
- ethoprop (Mocap 15G)—Consult label. Cabbage only.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.

## Broccoli, Brussels sprout, cabbage, cauliflower—Grasshopper

Various species

**Pest description and crop damage** Grasshoppers eat irregular holes in leaf tissue and can defoliate plants in high numbers, especially when swarming. Damage tends to be greatest on the edges of fields near pasture areas or roadsides. When wild grasses and other plants become dry, grasshoppers migrate to irrigated croplands.

### Management—Biological control

- *Nosema locustae* (Nolo Bait)—Use as manufacturer directs. It may be more effective applied to non-cultivated areas such as borders and pasture where grasshoppers breed. OMRI-listed for organic use.

### Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any on label plants surrounding the vegetable garden when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not listed for home use in OR.
- lambda-cyhalothrin
- malathion

- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A as granule. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Toxic in aquatic habitats.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/A as foliar spray, at 0.23 to 0.27 lb ai/A as soil treatment. PHI 1 day for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 3 days. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

**Broccoli, Brussels sprout, cabbage, cauliflower—Imported cabbageworm**

*Pieris rapae*

**Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

**Pest monitoring** The following information is from California but is generally applicable in the Pacific Northwest. Cabbageworms can be monitored at the same time as cabbage loopers. Sample 25 plants selected randomly throughout the field. Although treatment levels combine the two species, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant, often near the midribs of leaves. Good clues to cabbageworm presence include their greenish-brown fecal pellets, or many white cabbage butterflies fluttering around the field (check for eggs in a few days).

Base treatment on numbers of healthy larvae present. Treat seedlings or small plants if populations of medium-size to large caterpillars are high enough to stunt growth. Prior to heading, well-established plants do not need to be treated unless you find more than nine small to medium-size larvae per plant. Treat just before heading or at Brussels sprout formation if counts show more than one caterpillar in 25 plants.

An action threshold to prevent contamination of broccoli heads by cabbageworm larvae has not been established in Oregon. If large cabbageworm larvae are present in the field when broccoli heads begin to elongate, treatment is justified to prevent larvae from moving up into the heads in search of pupation sites. Preharvest clean up sprays alone generally do a poor job of removing the large cabbageworms once they have established themselves in the broccoli head.

**Management—biological control**

Natural enemies can assist significantly in the control of imported cabbageworm. Important parasites include the pupal, larval, and egg parasites in the *Trichogramma* genus, as well as tachinid flies. Timely mass releases of commercially available trichogramma during peak flight can be an effective control agent. Viruses and bacterial diseases are also sometimes important control factors in the field. If possible, use *Bacillus thuringiensis* to avoid adverse impact on natural enemies. *Bacillus thuringiensis* is very effective against imported cabbageworm, especially when applied to young (early-instar) caterpillars.

**Management—cultural control**

The use of resistant cabbage varieties such as Mammoth Red Rock, Chieftain Savoy, and Savoy Perfection Drumhead provides some protection, but not complete control. Make new plantings as far as possible from those of the previous year. At the end of the year, harvest crops without delay. Plowing under or destroying plant residues at this time eliminates an important food source for the overwintering generation of cabbageworms.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- carbaryl

- cyfluthrin
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not listed for use in OR.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90WDG) at 1.0 lb ai/A. PHI 14 days. REI 24 hr. Do not exceed 2 lb ai/A per season. Retreatment interval 7 days. Do not feed trimmings to livestock or allow animals to graze in treated areas. Brussels sprout and cauliflower only.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.030 to 0.048 ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- borate complex (Prev-Am) at 0.4% solution. REI 24 hr. Spray to complete coverage. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 5 Bait) at 1 to 2 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days. Do not exceed 4 treatments per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A at planting; via drip irrigation; as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for drip. Do not exceed 0.2 lb ai/A per season. Consult label for details.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. OMRI-listed for organic use. Product not registered for use in OR.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 5 days. Limit 3 treatments per crop. Do not exceed 0.16 lb ai/A per year. Some restrictions on application timing. Product not registered for use in WA.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A per season. Do not allow livestock to graze in treated areas.
- esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/A. PHI 3 days. REI 12 hr. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/A. PHI 7 days. REI 24 hr. Do not exceed 0.8 lb ai/A per season.
- flubendiamide/buprofezin (Vetica) at 0.21 to 0.42 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments. Do not exceed 0.84 lb ai/A per year. Product not registered for use in OR.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season. Toxic to bees.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A. PHI 3 days. REI 12 hr. A wetting agent is recommended. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per

year.

- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- malathion (Malathion 8) at 1.5 lb ai/A. PHI 2 days broccoli, Brussels sprout, cauliflower; 7 days for cabbage. REI 48 hr. Retreatment interval 7 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.23 to 0.9 lb ai/A. PHI 3 days for broccoli, cauliflower, and Brussels sprout; 1 day for cabbage. REI 48 hr. Do not annually exceed 5.4 lb ai/A for Brussels sprout, 6.3 lb ai/A for broccoli, and 7.2 lb ai/A for cabbage and cauliflower. Add a surfactant to improve coverage.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application and 0.12 to 0.16 lb ai/A for mid- to late-season application, or heavy infestation. PHI 1 day. REI 4 hr. Adding adjuvant improves performance. Do not exceed 1 lb ai/A per season.
- naled (Dibrom 8) at 0.94 lb ai/A. PHI 1 day. REI 48 hr. Do not exceed 9.4 lb ai/A per year. Retreatment interval 7 days. Limit 5 applications.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.156 lb ai/A per season.
- permethrin (Permethrin) at 0.05 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.8 lb ai/A on broccoli or 0.4 lb ai/A on cabbage, cauliflower and Brussels sprout per year.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not apply more than three times in a 30-day period. Do not exceed 0.45 lb ai/A or six applications per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early year or 0.12 lb ai/A mid to late year. PHI 7 days. REI 4 hr. Do not exceed 0.63 lb ai/A per year. Retreatment interval 10 days. Use of a surfactant is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year. Ground application only.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Looper

### Includes

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

**Pest description and crop damage** Both cabbage and alfalfa looper adults are brownish moths with distinctive silvery figures on the front wings. Eggs are ridged and dome-shaped and usually laid singly on the undersurface of leaves. Loopers are smooth-skinned with only a few long bristles down the back. They are green, usually with a narrow white stripe along each side and several narrow lines down the back. Alfalfa loopers tend to have more dark markings than cabbage loopers. Larvae may grow up to 1.5 inches long. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Looper caterpillars can be distinguished from most other common caterpillars by their distinctive looping movement, in which they arch the middle portion of their body to bring the hind legs forward to meet the front legs.

Cabbage looper larvae feed on leaves, causing ragged-edged holes in the leaf and on the leaf margins. The major damage caused by larvae and pupae is contamination of the heads of cole crops and severe defoliation of alfalfa, peas, sugar beets, beans, mint, and spinach. Alfalfa loopers tend to do less physical damage to plants, but are a serious source of contamination in processing.

**Biology and life history** The cabbage looper overwinters as a pupa either in the soil or in trash near the base of host plants. Moths begin emerging in May, and adults lay eggs singly on plants from late May until June. Eggs hatch in about a week. Larvae feed for 3 to 4 weeks before forming a pupal cocoon attached to leaves or trash. Adults from the second generation lay eggs as before, and larvae become damaging in August. There are two generations each year.

The alfalfa looper also overwinters as a pupa either in the soil or in trash near the base of host plants. Moths begin emerging in late April and May, and adults lay eggs singly on weed hosts, usually wild crucifers, rarely on crops. Eggs hatch in 3 to 5 days, and larvae feed for about 2 weeks before pupating on the host plant or in trash. The total development time is about 30 days. Adults emerge in about 7 days, mate, and females deposit eggs as before about 3 days after emerging. There are three or four generations each year.

**Pest monitoring** A sweep net can be used to sample for large larvae. Take at least 100 sweeps, in groups of 10, in different parts of the field and along the margins. Sequential sampling that involves fewer samples, and presence-or-absence sampling that does not involve counting, also may be used.

Pheromone traps can be used to monitor for the emergence of adult male moths. Alfalfa loopers tend to be caught in traps more often than cabbage loopers, sometimes leading to misreadings of which looper is the primary pest. Cabbage looper is the primary contaminant for harvested broccoli and the primary target of pest control tactics. More than five cabbage looper moths per trap per day constitutes significant egg-laying pressure. More than two to five large looper worms per 100 leaves 2 to 3 weeks prior to harvest of broccoli justifies an early and aggressive spray program.

The usual situation, however, is that all stages of worms are present at the same time. Unless close inspection is made, one may be easily misled into believing only large worms present and thus encounter a serious problem at harvest time. For this reason, carefully inspect plants to determine if small worms are present. If they are, control measures should be applied.

## Management—biological control

Cabbage loopers have many natural enemies that may keep them below economic levels if they are not killed by insecticide treatments for other pests. These include several important, naturally occurring parasites. A nuclear polyhedrosis virus disease is also important under certain circumstances.

Be sure to monitor for natural enemies. If looper populations are close to treatment thresholds, but you find a significant percentage of parasitized or disease-killed individuals, delay treatment for a few days to see if these natural controls will bring populations down on their own. If treatment is necessary, *Bacillus thuringiensis* insecticide minimizes injury to natural enemies.

## Management—cultural control

The use of resistant cabbage varieties such as Mammoth Red Rock, Chieftain Savoy, and Savoy Perfection Drumhead helps reduce cabbage looper damage. On most crucifers, however, chemical control of this pest becomes necessary.

## Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- esfenvalerate—Do not use on Brussels sprout.
- gamma-cyhalothrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

Control should be directed at the small worms. As the larvae reach maturity, they become difficult to control. The presence of larvae about 1 inch long indicates that development is about a week to 10 days from completion. Treatment of mature worms of cabbage or alfalfa looper within two weeks of harvest will likely have no measurable effect on yield or quality.

- acephate (Acephate 90WDG) at 1.0 lb ai/A. PHI 14 days. REI 24 hr. Do not graze or feed crop refuse to livestock. Retreatment interval 7 days. Brussels sprout and cauliflower only. Do not exceed 2 lb ai/A per year.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.06 to 0.09 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- borate complex (Prev-Am Ultra) at 0.4% solution. Spray to complete coverage. REI 24 hr. Retreatment interval is 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A a) at planting; b) via drip irrigation; c) as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for drip. Do not exceed 0.2 lb ai/A per season. Consult label for details.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 7 days for broccoli, cauliflower, and Brussels sprout, and 14 days for cabbage. REI 12 hr. Do not exceed 92 lb ai/A per season. Product not registered for use in OR.
- cyantraniliprole (Exirel) at 0.065 to 0.11 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 7 days. Limit 3 treatments per crop. Do not exceed 0.22 lb ai/A per year. Some restrictions on application timing. Product not registered for use in WA.

- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season.
- cypermethrin (Holster) at 0.075 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/A per season.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not use on Brussels sprout. Do not exceed 0.4 lb ai/A per year.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/A. REI 24 hr. PHI 7 days. Do not exceed 0.8 lb ai/A per season.
- flubendiamide/buprofezin (Vetica) at 0.21 to 0.42 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments. Do not exceed 0.84 lb ai/A per year. Product not registered for use in OR.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/A per season. Toxic to bees.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A. PHI 3 days. REI 12 hr. Use of wetting agent recommended. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- malathion (Malathion 8 Flowable) at 1.25 lb ai/A. PHI 2 days broccoli, Brussels sprout, cauliflower; 7 days for cabbage. REI 48 hr. Retreatment interval 7 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/A. PHI 3 days for Brussels sprout, broccoli, and cauliflower, 1 day for cabbage, 10 days for Chinese cabbage. REI 48 hr. Do not annually exceed 5.4 lb ai/A for Brussels sprout, 6.3 lb ai/A for broccoli, and 7.2 lb ai/A for cabbage and cauliflower. Add a surfactant to improve coverage.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application and 0.12 to 0.16 lb ai/A for mid- to late-season application or heavy infestation. REI 4 hr. PHI 1 day. Adding an adjuvant improves performance Do not exceed 1 lb ai/A per season.
- naled (Dibrom 8) at 1.8 lb ai/A. PHI 1 day. REI 48 hr. Do not exceed 9.4 lb ai/A per year. Retreatment interval 7 days. Limit 5 applications.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.156 lb ai/A per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.8 lb ai/A per year on broccoli or 0.4 lb ai/A on Brussels sprout, cauliflower, and cabbage per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Cabbage looper only. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed three times in a 30-day period. Do not exceed 0.45 lb ai/A or six applications per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early year; 0.12 lb ai/A mid to late year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/A per application or 0.625 lb ai/A per year. Reapplication on a 10- to 14-day schedule may be necessary under heavy infestations. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Retreatment interval 7 days.

## Broccoli, Brussels sprout, cabbage, cauliflower—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- Sodium ferric EDTA

**Management—chemical control: COMMERCIAL USE**

- iron phosphate/spinosad bait (Bug-N-Sluggo) at 24 to 44 lb/A. PHI 1 day. REI 4 hr.
- metaldehyde baits—Do not contaminate edible plant parts. Use as needed, but not more often than once per week.

## Broccoli, Brussels sprout, cabbage, cauliflower—Thrips

**Includes**

Western flower thrips (*Frankliniella occidentalis*)

Corn thrips (*Frankliniella williamsi*)

**Pest description and crop damage** Thrips are small insects about 0.03 inch long. Adult thrips have two pairs of narrow wings which are fringed with hairs. Immature thrips are wingless, whitish to yellowish, and are most commonly found on the underside of leaves. High numbers of thrips can cause stunting of small broccoli plants. However, thrips are not all bad. Foliage-feeding thrips are spider mite predators and help control spider mite population buildup in early spring.

**Biology and life history** Adults overwinter in trash, under bark, and in other protected places. Adults become active in the spring and lay eggs in the tissues of plants. The eggs hatch into nymphs, which begin feeding in flowers, buds, and leaves. When mature, nymphs drop to the ground and molt into adults. Under favorable conditions, a life cycle may require only 2 weeks.

**Pest monitoring** Treatment is usually not necessary on seedlings, because most plants recover from thrips injury. Thrips are also beneficial at this time because of their role as mite predators.

**Management—biological control**

Minute pirate bugs play a major role in controlling thrips populations.

**Management—cultural control**

Thrips populations tend to build up on weeds. Cultivating nearby weedy areas before plants emerge reduces the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after emergence increases thrips problems.

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- imidacloprid
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.075 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.375 lb ai/A or five applications per year. Retreatment interval 7 days.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.0125 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom. Adult thrips only.

- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb/A per season. Limit 5 applications after bloom.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/A per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/A as foliar spray, at 0.23 to 0.27 lb ai/A as soil treatment. PHI 1 day for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/A. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/A per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.172 lb ai/A of thiamethoxam per season.
- malathion (Malathion 8 Flowable) at 1.25 lb ai/A. PHI 3 days broccoli; 7 days for cauliflower, Brussels sprout and cabbage. REI 48 hr. Retreatment interval 7 days. Washington and Oregon only.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.156 lb ai/A per season.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.063 to 0.156 lb ai/A. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed three times in a 30-day period. Do not exceed 0.45 lb ai/A or six applications per crop. Entrust SC is OMRI-listed for organic use.
- sulfoxaflor (Closer SC) at 0.09 lb ai/A. PHI 3 days. REI 12 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/A per year. Suppression.
- thiamethoxam (Actara) at 0.047 to 0.086 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.

## Broccoli, Brussels sprout, cabbage, cauliflower—Wireworm

*Ctenicera* spp. and *Limoniuss* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season. Adults only.
- bifenthrin (Capture LFR) 0.04 to 0.08 lb ai/A at planting in furrow or broadcast to soil surface. Do not exceed 0.1 lb ai/A per season as an at plant application. Do not exceed 0.5 lb ai/A per season for foliar and at plant.
- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/A in-furrow with the seed or transplant. REI 12 hr.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Wireworm adults only. Do not exceed 0.5 lb ai/A per year. Do not make more than five applications after bloom. Do not make applications less than 7 days apart.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 5 days. Retreatment interval 7 days. Do not exceed 0.5 lb ai/A per season. Limit 5 treatments. Product not registered for use in OR.
- chloropicrin (Telone II)—Preplant.
- diazinon (Diazinon 50W) at 3 to 4 lb ai/A broadcast just before planting and immediately incorporate into the top 4 to 8 inches of soil. REI 4 days.

## Cantaloupe—see Melon

## Carrot—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Willow-carrot aphid (*Cavariella aegopodii*)

**Pest description and crop damage** The green peach aphid is slender, dark green to yellow, and has no waxy bloom. The wingless form of the green peach aphid is pale green. The winged form has a black head and thorax. It is primarily an early season pest and transmits virus diseases. The willow-carrot aphid is pale greenish yellow. The winged form is pale yellow marked with black. Its primary host is willow, but it feeds on carrots during the summer. The bean aphid is dark olive green to black with light-colored legs. It is usually more of an early season pest.

Aphids feed on carrot foliage, but they are a key pest because they can transmit diseases such as motley dwarf virus. In general, aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunt; by excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and by spreading plant diseases (a large number of viruses are spread by aphids).

### Biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedlings emerge. If aphids become numerous, increase the frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent aphid dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Populations tend to be higher in crops that are fertilized liberally with nitrogen. Home gardeners can often get effective control by washing aphids with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves as allowed per label.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- insecticidal soap (often as a mix with spinosad)—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage It acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- malathion
- plant-derived essential oils (clove, rosemary, etc.)—Some have demonstrated efficacy on aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/100 gal spray volume. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.
- borate complex (Prev-Am) applied as a 0.8% solution. Spray to complete coverage. PHI 1 day. REI 24 hr. Retreatment interval 7 to 10 days.

OMRI-listed for organic use.

- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Battalion 1.5EC) at 0.012 to 0.028 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/A per season. Aphids are not listed for cucurbit vegetables, but this product is effective at suppression of aphids.
- flonicamid (Beleaf 50SG) at 0.062 to 0.088 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/A per season. Limit to 3 applications. Does not specify carrot aphid on label, however this product is effective against several aphid populations.
- flupyradifurone (Sivanto 200 SL) at 0.09 to 0.16 lb ai/A (7 to 12.0 fl oz/A). PHI 21 days. REI 4 hr. PHI 24 hr. Do not exceed 0.365 lb ai/A or 28.0 fl oz/A per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire Pro) at 0.156 to 0.375 lb ai/A, or 0.011 to 0.027 lb ai/1,000 row feet (7 to 10 fl oz/A). Soil application only. PHI 21 days. REI 12 hr. One treatment per season only. Do not exceed 0.375 lb ai/A per year. Use an organosilicone-based spray adjuvant for applications targeting aphids.
- imidacloprid (Prey 1.6) at 0.044 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed three treatments per season. Do not exceed 0.13 lb ai/A per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/A. PHI 0 days. REI 12 hr.
- malathion (numerous products) at 1 to 1.25 lb ai/200 gal. PHI 7 days. REI 12 to 24 hr depending on product. Please refer to label instructions.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. REI 12 hr. PHI 7 days. Do not exceed 0.125 lb ai/A per year. Retreatment interval 7 days.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/A soil applied. REI 12 hr. Do not exceed 0.188 lb ai/A per season.
- Sufoxaflor (Transform WG) at 0.75 to 1.0 oz/A. Do not exceed 8.5 oz/A. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed. Not for use on seed crops.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year.

## Carrot—Carrot rust fly

*Psila rosae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Yellow sticky traps can be used to monitor for carrot rust fly. In Ontario, Canada, an action threshold of one-tenth to two-tenths flies per trap per day is used. Degree-day accumulations have been calculated for carrot rust fly development.

Begin monitoring carrots at the second leaf stage. Symptoms of larval attack are wilting and discolored (“rusty”) foliage, especially in dry weather. Less severely damaged plants appear stunted.

### Management—cultural control

Rotating crops plays an important role in reducing populations of this pest. Destroy volunteer carrots and all umbelliferous plants, as they may serve as alternate hosts and possible sources of infestation. Early harvest helps control damage. If early harvest is not possible, harvest in blocks rather than selectively. Deep plowing in fall or spring can be helpful. Floating row covers work very well and may be cost effective on high value crops.

### Management—chemical control: HOME USE

No products are registered for control of this pest.

### Management—chemical control: COMMERCIAL USE

- clothianidin + imidacloprid (Sepresto 75 WS) at 0.06 to 0.12 oz formulated product/1,000 seeds. For use in commercial seed treaters only. Not for use in agricultural establishments in hopper-box or similar on-farm seed treatment applicators used at planting. Regardless of the type of application (seed treatment, soil, or foliar), do not exceed 6 oz ai/A clothianidin or 8 oz ai/A imidacloprid per acre per season. Not registered for use in OR.

## Carrot—Cutworm and armyworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variiegated cutworm (*Peridroma saucia*)

Various species of armyworm

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

Home gardeners: Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations OMRI-listed for organic use. Not registered for use in OR.
- pyrethins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin WG)—See product labels for rates. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.11 lb ai/A or five treatments per season.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/A. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/A per season.
- carbaryl (Sevin 5 bait) at 2 lb bait/A. PHI 7 day. REI 12 hr. Do not exceed 5 lb ai/A per crop. Apply bait for both cutworm and armyworm at the first sign of activity.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A for foliar feeding larvae. PHI 7 days. REI 12 hr. Do not exceed 5 lb ai/A per crop.
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 4 applications per crop or 0.2 lb ai/A per crop.
- clothianidin/imidacloprid (Sepresto 75) at 0.002 to 0.0042 oz formulated product/1,000 seeds. Do not exceed 6 oz ai/A clothianidin or 8 oz ai/A imidacloprid per acre per season. Not registered for use in OR.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin/essential oils (Shooter) at 0.01 lb ai/A deltamethrin. PHI 3 days. REI 12 hr. Do not exceed 0.14 lb ai/A deltamethrin per season.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/A as broadcast. Incorporate into top 3 to 4 inches into soil before planting. REI 3 days.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per year. See label for restrictions on ground versus aerial applications. For cutworm only. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate SP) Treat cutworms at 0.23 to 0.45 lb ai/A and armyworms at 0.45 to 0.9 lb ai/A. PHI 1 day. REI 48 hr. Not more than 10 applications or 6.3 lb ai/A per year.
- methoxyfenozide (Intrepid 2F) at 0.09 to 0.25 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 14 days. Do not exceed 1 lb ai/A per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Radiant SC) at 0.0469 to 0.0625 lb ai/A. PHI 3 days. REI 4 hr. Retreatment interval 4 days. Do not exceed four applications or 0.219 lb ai/A per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.047 to 0.094 lb ai/A. PHI 3 days. REI 4 hr. Do not exceed 0.33 lb ai/A or four applications per season. Retreatment interval 5 days. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.016 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Do not use tops for feed or fodder. Armyworms only.

See:

Corn, sweet—Armyworm

Corn, sweet—Cutworm

## Carrot—Garden symphylan

*Scutigera immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. In general, preplant field evaluation for symphylans involves grid

sampling at one-acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample. However, symphylans may cause cosmetic injury to carrots sold as fresh produce.

#### **Management—biological control**

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

#### **Management—cultural control**

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with non-host crops has not been studied.

#### **Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—No registered bifenthrin products for carrot in WA.
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- dichloropropene (Telone II)—Preplant incorporation using broadcast application 9 to 12 gal/A.

## **Carrot—Sixspotted leafhopper**

*Macrostelus fascifrons*

**Pest description and crop damage** The sixspotted leafhopper also is known as the aster leafhopper. It is about 0.19 inch long, narrow, wedge-shaped, with a beak, tiny antennae, and long hind legs fringed with hairs. It is yellow or yellow-green with six black spots arranged in three rows on its head. Eggs are translucent at first but soon turn white. Adults are relatively poor fliers and tend to glide along with wind currents. Nymphs resemble a wingless adult but are much smaller, ranging in size from 0.03 to 0.12 inch long. They often can be distinguished by their unique sideways scuttle when disturbed. Young larvae are white but soon become yellow with brown markings.

Feeding damage causes a yellow, speckled appearance. This is usually minor. The sixspotted leafhopper is the primary vector of aster yellows phytoplasma (AYP), a serious virus-like plant disease in the Pacific Northwest. Aster yellows infection prior to bulking of the carrot root causes root proliferation which is a problem for carrots destined for processing plants.

**Biology and life history** The sixspotted leafhopper overwinters as an egg in northern locations and in the adult stage in warmer climates. It undergoes a series of five nymph stages before reaching adulthood. Each generation requires 27 to 34 days to complete. There are three to four generations each year.

**Pest monitoring** Leafhoppers easily are collected with sweep nets. Yellow sticky traps also are useful.

#### **Management—cultural control**

Mulches of aluminum foil and straw can help reduce disease incidence. Row covers also can be used on higher value crops. Destruction of weed species known to harbor aster yellows is also important.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—When applied to foliage, it acts as a repellent to some insect pests. Some formulations OMRI-listed for organic use. Not listed for home use in OR.
- malathion
- plant-derived essential oils (clove, rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL, Tombstone Helios) at 0.013 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.11 lb ai/A or five applications per season.
- carbaryl (Sevin XLR Plus) at 0.5 to 1 lb ai/A. PHI 7 day. REI 12 hr. Do not exceed 5 lb ai/A per crop or five applications per year. Retreatment interval 7 days.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 7 days. REI 12 hr. See label for ground versus aerial application restrictions. Do not exceed 0.5 lb ai/A per year.
- flupyradifurone (Sivanto 200 SL) at 7 to 10.5 fl oz/A. PHI 21 days. REI 4 hr. Do not exceed 0.365 lb ai/A per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire Pro) at 0.156 to 0.375 lb ai/A or 0.011 to 0.027 lb ai/1,000 row feet. Soil application only. PHI 21 days. REI 12 hr. One treatment per season only. Do not exceed 0.38 lb ai/A.
- imidacloprid (Prey 1.6) at 0.044 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed three treatments per season.
- malathion (Numerous Products) at 1.25 lb ai/A (see label). PHI 7 days. REI 12 - 24 hr.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/A. PHI 1 day. REI 48 hr. Not more than 10 applications or 6.3 lb ai/A per year.
- sulfoxaflor (Transform WG) at 1.5 to 2.75 oz/A. Do not exceed 8.5 oz/A. PHI 7 days. REI 24 hr. If blooming vegetation is present 12 out from the downwind edge of the field, a 12 foot in-field down wind buffer must be observed. Not for use on seed crops.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.125 lb ai/A per year. Retreatment interval 7 days.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/A soil applied. REI 12 hr. Do not exceed 0.188 lb ai/A per season.
- zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per year. Do not use tops for feed or fodder.

**Carrot—Slug****Includes**

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

**Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

**Management—biological, cultural, tactical**

See:

Slug Control

**Management—chemical control: HOME USE**

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

**Management—chemical control: COMMERCIAL USE**

- metaldehyde baits. Do not contaminate edible plant parts. Use as needed but not more than once per week.
- iron phosphate baits at 0.24 to 0.44 lb ai/A. PHI 0 days. REI: no restrictions.

**Carrot—Wireworm**

Several species

**Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

**Management—biological, cultural, tactical**

See:

Potato, Irish—Wireworm

**Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- diazinon (Diazinon 50W) at 3 to 4 lb ai/A (10 gal/A min). Broadcast and mix into soil before planting. REI 3 days. Do not apply more than 8 lb of formulated product (4 lb ai/A per calendar year.
- dichloropropene (Telone II)—Registered for preplant soil treatment for nematodes and reduces wireworm populations in soil.
- imidacloprid (Gaucho 480F) at 0.25 lb ai/100 lb of seed. Apply as commercial seed treatment.

## Celery—Aphid

**Includes**

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Willow-carrot aphid (*Cavariella aegopodii*)

**Pest description and crop damage** The willow-carrot aphid is green to greenish yellow. Its primary host is willow, but it feeds on carrot during the summer. The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Green peach aphid infestations may result in wilting. The bean aphid is dark olive green to black with light-color legs. It is usually more of an early-year pest.

**Biology and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots but avoid sampling only those areas. Also, be sure to look for evidence of biological control, i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

**Management—biological control**

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

**Management—cultural control**

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. *Home gardeners* can often get effective control by washing aphids with a strong stream of water.

**Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage It acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90 WDG) at 0.5 to 1.0 lb ai/A. PHI 21 days. REI 24 hr. Retreatment interval 7 days. Trim tops. Do not use tops for food or feed. All celery must be trimmed before shipment for use. Do not exceed 2 lb ai/A per year.
- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.375 lb ai/A or five applications per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL, Tombstone) at 0.019 to 0.022 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/A per season. Avoid use when bees are foraging.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar; 0.15 to 0.2 lb ai/A soil. PHI 7 days foliar treatment; 21 days soil treatment. REI 12 hr. Foliar retreatment interval 10 days. Do not exceed 0.2 lb ai/A per season. Do not apply when bees are actively foraging.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year. An adjuvant will improve efficacy.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/A as foliar treatment or 0.23 to 0.27 lb ai/A as a soil treatment. PHI 7 days foliar; 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A (foliar) or 0.532 lb ai/A (soil) per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/A or three applications per season. Retreatment interval 7 days.
- flupryadifurone (Sivanto 200SL) at 0.14 to 0.16 lb ai/A. PHI 1 day. REI 4 hr. Limit 3 treatments per season. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per season.
- imidacloprid (Admire Pro) at 0.158 to 0.38 lb ai/A. Soil application only. PHI 45 days. REI 12 hr. Do not exceed 0.38 lb ai/A per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/A. PHI 0 days. REI 12 hr.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not graze or feed treated plants. Do not exceed 1 lb ai/A per year.
- pymetrozine (Fulfill) at 0.086 lb ai/A. A penetrating adjuvant improves performance. PHI 7 days. REI 12 hr. Do not exceed 0.17 lb ai/A per season. Retreatment interval 7 days. Not registered for use in OR.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/A. PHI 1 day. REI 12 hr. Limit 2 treatments per season, maximum 6 treatments per calendar year. Retreatment interval 7 days. Do not exceed 0.21 lb ai/A per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/A. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/A. PHI 3 days. REI 12 hr. Limit 4 treatments per crop. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. Soil application only. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A PHI 1 day. REI 12 hr. Limit 4 applications per year; 2 per crop cycle. Retreatment interval 14 days. Do not exceed 0.42 lb ai/A per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 7 days.

## Celery—Carrot rust fly

*Psila rosae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Orange or yellow sticky traps can be used to monitor for carrot rust fly. In Ontario, Canada, an action threshold of 0.1 to 0.2 flies per trap per day is used. Degree-day accumulations have been calculated for carrot rust fly development. Begin monitoring celery at the second-leaf stage. Symptoms of larval attack are wilting and discolored (“rusty”) foliage, especially in dry weather. Less severely damaged plants appear stunted.

### Management—biological, cultural, tactical

See:

Carrot—Carrot Rust Fly

### Management—chemical control: HOME USE

No products are registered for control of this pest

### Management—chemical control: COMMERCIAL USE

None registered.

## Celery—European earwig

*Forficula auricularia*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** If you are seeing damage to young shoots of vegetables or perennials, you can confirm the presence of earwigs in the garden by placing a sheet of corrugated cardboard, hollow bamboo cane, sections of old garden hose, or similar material that will provide shelter in the garden. Check the materials each morning for presence of the insects.

### Management—cultural control

Cultivation of the soil in early spring in areas where earwigs are present will disturb nests and expose eggs to predators. Do not allow debris and decaying organic matter to accumulate in the garden. Starting vegetable gardens early will give young plants a chance to grow before nymphs become active.

*Homeowners:* Earwigs can be trapped by using the monitoring techniques described above. Empty traps each morning into a pail of water topped with detergent. Earwigs are attracted strongly to fish oil and to some extent to vegetable oil. Insects can be trapped by filling shallow containers with the oil and burying it in soil up to its rim.

### Management—biological control

Tachinid flies are predators of earwigs. They are dark brown with pinchers at the rear end. They often feed in blossoms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use on celery in WA.
- carbaryl
- cyfluthrin
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- clothianidin (Belay) at 0.15 to 0.2 lb ai/A soil. PHI 21 days. REI 12 hr. One application as broadcast, narrow band, in-furrow, as sidedress, seedling or transplant drench or through chemigation.

## Celery—Lepidoptera larvae

### Pest description, crop damage and life history

See “Armyworm” and “Cutworm” in:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use on celery in WA.
- carbaryl
- cyfluthrin
- permethrin
- plant derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90 WDG) at 1 lb ai/A. PHI 21 days. REI 24 hr. Retreatment interval 7 days. Do not use tops for food or feed. All celery must be trimmed before shipment for use. Do not exceed 2 lb ai/A per year.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- *Bacillus thuringiensis* (Javelin WG) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr (see label). Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- bifenthrin (Brigade WSB, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Limit 4 treatments per season. Retreatment interval 3 days foliar, 10 days drip chemigation. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year. An adjuvant will improve efficacy
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A or four applications per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.06 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- flubendiamide/buprofezin (Vetiva) at 0.25 to 0.35 lb ai/A. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 7 days. Do not exceed 0.79 lb ai/A per year. Not registered for use in OR.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/A per season. Retreatment interval 3 days.
- methomyl (Lannate SP) at 0.23 to 0.9 lb ai/A. PHI 7 days. REI 48 hr. Limit 8 treatments per year. Do not exceed 6.3 lb ai/A per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application and 0.12 to 0.16 lb ai/A for mid- to late-season application or heavy infestation. REI 4 hr. PHI 1 day. Adding a spreader-sticker improves performance. Do not exceed 1 lb ai/A per season.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not graze or feed treated plants. Do not exceed 1 lb ai/A per year.
- permethrin (Loveland Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/A per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.023 to 0.125 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed three times in any 30-day period. Do not exceed 0.45 lb ai/A or six applications per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early year; 0.12 lb ai/A mid- to late year. PHI 7 days. REI 4 hr. Do not exceed 0.625 lb ai/A per year. Retreatment interval 10 days. Use of a surfactant is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 7 days.

## Celery—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

## Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- Sodium ferric EDTA.

### Management—chemical control: COMMERCIAL USE

- iron phosphate baits/spinosad (Bug-N-Sluggo) at 20 to 44 lb/A formulated product. PHI 1 day. REI 4 hr.
- metaldehyde baits—Do not contaminate edible plant parts.

## Chard, Swiss—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

**Pest description and crop damage** The bean aphid is dark olive green to black with light-color legs. It is usually more of an early-year pest. The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Green peach aphid infestations may result in wilting.

*See:*

Common Pests of Vegetable Crops

### Biology and life history

*See:*

Common Pests of Vegetable Crops

Slug Control

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. *Home gardeners* can often get effective control by washing aphids with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves as label indicates.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use in WA.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin

- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

##### Please refer to label as some chemistries are only available in dust formulations.

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed five applications per year or 0.375 lb ai/A per season. Retreatment interval 7 days.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. REI 4 hr. PHI 0 days. OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution. Spray to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem Prime) at 2 to 4 quarts formulated product per acre. PHI 0 days. REI 4 hr. Not listed for aphid in Swiss chard.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar or 0.15 to 0.2 lb ai/A soil treatment. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days foliar. Do not exceed 0.2 lb ai/A per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/A foliar or 0.23 to 0.27 lb ai/A soil. PHI 7 days for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil application per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/A or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200 SL) at 0.14 to 0.16 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per season. Limit 3 treatments per season.
- imidacloprid (Admire Pro) at 0.156 to 0.38 lb ai/A. Soil application only. PHI 45 days. REI 12 hr. Do not exceed 0.38 lb ai/A per season.
- insecticidal soap (M-Pede) as 1 to 2% solution. Potassium salts of fatty acids. See label for gal/A. PHI 0 days. REI 12 hr.
- malathion (Malathion 8) at 1 lb ai/A. PHI 14 days. REI 12 hr. Limit 2 applications. Retreatment interval 7 days.
- naled (Dibrom 8E) at up to 0.94 lb ai/A. PHI 2 days. REI 48 hr. Do not exceed 6.6 lb ai/A per season. Retreatment interval 7 days.
- permethrin (Pounce 25 WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not graze or feed. Do not exceed 1 lb ai/A per season. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 lb ai/A. Adding a penetrating adjuvant improves performance. REI 12 hr. PHI 7 days. Do not exceed 0.17 lb ai/A per season. Retreatment interval 7 days. Not registered for use in OR.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/A. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/A per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/A. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/A. REI 12 hr. PHI 3 days. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/A per year.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/A per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. Soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.196 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Chard, Swiss—Armyworm, cutworm, and looper

Various species

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

## Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

## Management—chemical control: HOME USE

Apply any one of these materials as suggested on label at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use in WA.
- carbaryl
- cyfluthrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5-B) at 0.018 to 0.049 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin WG) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution. Spray to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate CG) at 1 to 4 quarts/A product (according to location, please see label for quantities). PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 14 days. REI 12 hr. Limit 5 treatments per year. Do not exceed 6 lb ai/A per crop.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/A per crop or 0.8 lb ai/A per season. Foliar retreatment interval 3 days; drip 10 days.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 5 days. Limit 3 treatments per crop. Do not exceed 0.16 lb ai/A per year. Some restrictions on application timing. Product not registered for use in WA.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Retreatment interval 7 days.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.045 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- flubendiamide/buprofezin (Vetica) at 0.25 to 0.35 lb ai/A. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 7 days. Do not exceed 0.79 lb ai/A per year. Product not registered for use in OR.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per crop. Limit 4 treatments.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/A. PHI 10 days. REI 48 hr. Do not exceed 8 applications or 3.6 lb ai/A per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application and 0.12 to 0.16 lb ai/A for mid- to late-season application or heavy infestation. PHI 1 day. REI 4 hr. Adding a spreader-sticker improves performance. Do not exceed 1 lb ai/A per season.
- naled (Dibrom 8E) at up to 0.94 lb ai/A. PHI 2 days. REI 48 hr. Do not exceed 6.6 lb ai/A per season. Retreatment interval 7 days. Do not apply when temperature is over 90°F. Limit 7 treatments per season.
- permethrin (Pounce 25WP) at 0.05 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not graze or feed. Do not exceed 1 lb ai/A per season. Retreatment interval 7 days.
- permethrin (Loveland Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not graze or feed. Do not exceed 0.2 lb ai/A per season. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266

lb ai/A per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Armyworms and cabbage looper only.

- spinosad (Success, Entrust SC) at 0.047 to 0.125 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early-year; 0.12 lb ai/A mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 0.625 lb ai/A per crop cycle. Retreatment interval 10 days. A surfactant improves control.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.196 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

*See:*

Corn, sweet—Armyworm

Corn, sweet—Cutworm

Broccoli, Brussels sprout, cabbage, cauliflower—Looper

## Chard, Swiss—Blister beetle

*Epicauta* spp.

**Pest description and crop damage** Adults are slender, oblong beetles with a relatively large head and an extenuated neck, often with yellow stripes in some form. Eggs are oblong and yellow. Larvae usually are found in several stages. All stages have three upper body legs. The pupa is a stage of darkening, starting with the eyes. The beetles get their name from a toxin they contain called cantharidin. Even dead insects can cause blisters if handled.

Blister beetles are mostly foliage feeders but are not considered a major pest of vegetable crops. While feeding, they leave behind a distinctive black stringy substance. The beetles tend to move in swarms and can cause a great deal of localized defoliation. They generally do not stay in one area for very long.

**Biology and life history** Blister beetles pass the winter in a pseudopupa stage and then go through a final molt in the spring. After a short period of activity, the larva enters the true pupal stage. Adults emerge in midsummer. There is a single generation each year. Blister beetles tend to stay in weedy areas, especially where there is an abundance of grasshopper eggs. Larvae are considered beneficial, as they can consume large amounts of grasshopper eggs. Only the adult stage damages the crop.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use in WA on Swiss chard.
- carbaryl
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- malathion (Malathion 8) at 1 lb ai/A. PHI 14 days. REI 12 hr. Retreatment interval 7 days, 2 lb/A per year. Blister beetles are not specifically cited in Swiss chard on the label, however Malathion has been effective in treating blister beetle in other crops. Washington and Oregon only.

**Note:** Blister beetles are controlled easily with insecticides.

## Chard, Swiss—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Specific treatment thresholds have not been established for foliage feeding in Oregon. In Virginia, the following recommendations are made: To prevent cucumber beetle damage to seedlings, treat when one beetle per 10 feet of row is found.

Be aware of surrounding fields. As grass fields dry down prior to harvest, and when harvested vegetable crops are disked into the soil, sudden surges in beetle pressure occur as beetles migrate in from other areas.

### Management—cultural control

In most years, low ebbs occur in the aboveground adult beetle populations after egg laying and prior to the emergence of the summer generation. Sometimes, the timing of a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Trap and spray crops

sometimes can be used to draw beetles away from the main crop or intercept incoming beetles at the edge of the field. Trap cropping is an unproven control method in Oregon.

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use in WA.
- carbaryl
- cyfluthrin
- imidacloprid
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 6 lb ai/A per crop. Cucumber beetles are not specifically cited on the label. Retreatment interval 7 days. Washington and Oregon only.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/A foliar or 0.23 to 0.27 lb ai/A soil. PHI 7 days for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil application per season.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Chard, Swiss—Flea beetle

Various species

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use on celery in WA.
- carbaryl
- cyfluthrin
- imidacloprid
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/A per season. Retreatment interval 7 days.
- carbaryl (Sevin XLR Plus) at 0.5 to 1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days. Limit 5 treatments per year. Phytotoxicity may occur under certain conditions.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar or 0.15 to 0.2 lb ai/A soil treatment. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days foliar. Do not exceed 0.2 lb ai/A per season.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Retreatment interval 5 days. Limit 3 treatments per crop. Do not exceed 0.16 lb ai/A per year. Some restrictions on application timing. Harvanta is not registered for use in WA.

- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season. Toxic to bees.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/A foliar or 0.23 to 0.27 lb ai/A soil. PHI 7 days for foliar; 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil application per season.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. Soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.196 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.42 lb/A per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Chard, Swiss—Leafminer

### Includes

Pea leafminer (*Liriomyza huidobrensis*)  
Vegetable leafminer (*L. sativae*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long, stiff bristles. Larvae are a nearly translucent white or yellow and about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups. Both larvae and adults damage plants. Larval feeding results in slender, winding trails on the leaves, which form large, white blotches when mining becomes severe. Adults can make as many as 100 feeding punctures on a single leaf. Around 5% of these punctures may contain actively feeding larvae. Excessive mining renders leaves unmarketable, reduces photosynthetic capacity, and provides easy access for disease organisms.

**Pest monitoring** Regularly check young seedlings and plants for leaf mines. Most mines occur on cotyledons and the first true leaves. Some mines are more visible when seen from the underside of the leaf.

### Management—biological control

Natural enemies, especially parasitic wasps, commonly reduce populations of leafminers, unless they are killed off by insecticides applied to control other pests. To avoid killing beneficials, choose selective pesticides for treating other pests, whenever possible. Other parasites attack leafminers, but because leafminers feed within the leaf, they generally are protected from predators.

### Management—cultural control

Row covers work well in excluding egg-laying female flies.

*Home gardeners:* remove and destroy affected leaves.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use on celery in WA.
- carbaryl
- cyfluthrin
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/A per season. An organosilicone surfactant will increase translaminar uptake and transport.
- azadirachtin (Neemix 4.5-B) at 0.018 to 0.048 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Chenopodium ambrosioides* extract (Requiem Prime) at 3 to 4 quarts formulated product per acre. PHI 0 days. REI 4 hr. For suppression only, begin treatments before thresholds have been reached.
- chlorantraniliprole (Coragen) at 0.065 to 0.098 lb ai/A as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/A per crop or 0.8 lb ai/A per season. Controls larvae.
- clothianidin (Belay) at 0.15 to 0.2 lb ai/A soil treatment. Suppression. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year.
- dimethoate (Dimethoate 4EC, Dimethoate LV-4) at 0.25 lb ai/A. PHI 14 days. REI 48 hr. Do not exceed 1.5 lb ai/A per season. Retreatment interval 7 days.

- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/A (foliar) or 0.23 to 0.27 lb ai/A (soil) treatment. PHI 7 days foliar or 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/A foliar or 0.532 lb ai/A soil application per season.
- emamectin (Proclaim) at 0.01 to 0.015 lb ai/A (suppression only). PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A per season.
- naled (Dibrom 8E) at 0.94 lb ai/A. PHI 2 day. REI 48 hr. Do not exceed 6.6 lb/A per season. Retreatment interval 7 days. Do not apply when temperature is over 90°F. Limit 7 treatments.
- permethrin (Pounce 25WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not graze or feed. Do not exceed 1 lb ai/A per season. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.0469 to 0.0781 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Follow resistance management procedures on the label. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.09 to 0.156 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. A surfactant improves control. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. Soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Suppression.

## Chard, Swiss—Wireworm

*Limoniusspp.*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin—Not registered for home use on celery in WA.
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (TeloneII)—Preplant.

## Collard and kale—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Green peach aphid (*Myzus persicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

**Pest description and crop damage** The cabbage aphid is gray-green with a waxy bloom. It forms dense colonies that cannot be removed before processing or marketing. The turnip aphid looks very much like the cabbage aphid but lacks the waxy bloom. It tends to be more evenly distributed over plants. The green peach aphid is slender, dark green to yellow, and has no waxy bloom. It is primarily an early year pest. Green peach aphid infestations may result in wilting.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these

natural enemies if the crop is not entering a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases.

*Home gardeners* can often get effective control by washing aphids with a strong stream of water.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)—Not registered for home use on celery in WA.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on kale.
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Do not use on kale. Not registered for use in OR.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.375 lb ai/A per year or 4 applications per season. Retreatment interval 7 days.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5-B) at 0.018 to 0.049 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- borate complex (Prev-Am Ultra) applied as a 0.8% solution. Spray to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem Prime) at 4 to 8 pints formulated product per acre. REI 4 hr. Limit 10 applications. Use high rate when conditions are favorable for heavy pressure.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar, 0.15 to 0.2 lb ai/A soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/A per season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year.
- dimethoate (Dimethoate 4EC, Dimethoate LV-4) at 0.25 lb ai/A. PHI 14 days. REI 48 hr. Do not exceed 1.5 lb ai/A per season. Retreatment interval 15 days. Kale only.
- dinotefuran (Venom) at 0.088 to 0.131 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.263 lb ai/A per season. Retreatment interval 7 days. Limit 3 treatments.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/A per season. Limit 3 applications. Retreatment interval 7 days.

- flupyradifuron (Sivanto 200 SL) at 0.09 to 0.16 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/A soil and 0.047 lb ai/A foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Foliar retreatment interval 5 days. Do not exceed 0.38 lb ai/A soil or 0.23 lb ai/A foliar per year.
- imidacloprid (Prey 1.6) at 0.0475 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/A per year.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/A. PHI 0 days. REI 12 hr.
- malathion (Malathion 8) at 1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval kale 5 days, collards 7 days. Limit 3 applications.
- naled (Dibrom 8E) at 0.94 lb ai/A. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatments per season. Do not exceed 9.4 lb ai/A per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/A. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/A per year. Apply by ground equipment.
- pymetrozine (Fulfull) at 0.086 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Retreatment interval 7 days.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/A. REI 12 hr. PHI 3 days. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/A per year. Product not registered for use in kale or collards in OR.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/A per year.

## Collard and kale—Armyworm, cutworm, and looper

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Black cutworm (*Agotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

**Pest description and crop damage** Several species of armyworm, cutworm, and looper attack collards and kale. Armyworm larvae feed in colonies shortly after hatching and skeletonize leaves. As they grow larger, they tend to disperse and consume irregular patches of foliage or entire leaves. Their fecal material (frass) contaminates harvested portions of the crop.

Cutworms do most of their feeding near the soil line, often cutting off seedlings at ground level. The variegated cutworm in particular also climbs up into plants to feed. Cabbage looper larvae feed on leaves, causing ragged-edge holes in the leaf and on the leaf margins. The major damage caused by larvae and pupae is contamination of the heads of cole crops.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on kale.
- kaolin—When applied as a spray to foliage it acts as a repellent to some insect pests. Some formulations OMRI-listed for organic use. Do not use on kale. Not for home use in OR.

- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A. PHI 14 days. REI 12 hr. Limit 3 treatments per year. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days. Limit 3 applications.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A as soil, chemigation or foliar treatment. PHI 3 days. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 3 days foliar, 10 days drip chemigation. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 92 lb ai/A per season. Collards only. OMRI-listed for organic use. Not registered for use in OR.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year. Limit 6 treatments per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Limit 3 treatments per crop. Retreatment interval 7 days. Do not exceed 0.22 lb ai/A per year. Not registered for use in WA.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per year.
- diazinon (Diazinon AG500) at 2 to 4 lb ai/A broadcast just before planting (10 gal/A min). Broadcast just before planting and immediately incorporate into the top 3 to 4 inches of soil. REI 4 days.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/A. REI 12 hr. PHI 14 days. Do not exceed 0.06 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 7 days. REI 12 hr. Do not feed crop residue. Do not exceed 0.2 lb ai/A per year. Collards only.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A. PHI 3 days. REI 12 hr. Limit 4 treatments per year. Do not exceed 0.26 lb ai/A per crop. Retreatment interval 3 days.
- malathion (Malathion 8) at 1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval kale 5 days, collards 7 days. Limit 3 applications.
- methomyl (Lannate SP) at 0.45 lb to 0.9 lb ai/A. PHI 10 days. REI 48 hr. Do not exceed 5.4 lb ai/A collards per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application or at 0.12 to 0.16 lb ai/A for mid- to late-season application. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/A per season.
- naled (Dibrom 8E) at 1.88 lb ai/A. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatments per season. Do not exceed 9.4 lb ai/A per year. Loopers only.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success) at 0.047 to 0.156 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. Some formulations are OMRI-listed for organic use.
- *Spodoptera frugiperda* (Fawligen) at 1 to 2.4 fl oz product per acre. PHI 0 day. REI 4 hr. Beet armyworm and fall armyworm only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early-year; 0.12 lb ai/A mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/A per application or 0.625 lb ai/A per year. Use of a surfactant is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per sea-

son.

## Collard and kale—Cabbage maggot

*Delia brassicae*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate.

If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments have little value.

Sticky traps and sweep nets also can be used to monitor the adult fly.

### Management—biological control

Rove beetles prey on maggot eggs and young larvae. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp, *Trybliographa rapae*, lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

### Management—cultural control

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seed row. It is believed that adult flies can locate the seed row for egg-laying by honing in on the higher moisture levels created when the soil is overturned for planting.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops, unless sufficient time has passed for the residue to dry or decompose completely.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

Every year, in areas where cabbage maggot causes economic injury, treat spring planted or transplanted crops with a band of insecticide at the base of the plant at the time of planting or transplanting. Later sprays cannot be relied upon to control the pest effectively. Treat seedbeds for transplanted crops with an insecticide.

*See:*

Broccoli, Brussels sprout, cabbage, cauliflower—Cabbage maggot

## Collard and kale—Diamondback moth

*Plutella xylostella*

**Pest description and crop damage** Diamondback larvae are smaller than most other caterpillars in cole crops, about 0.31 inch when full grown. The larval body is wider in the middle and tapers at both ends, with two legs (prolegs) on the last segment forming a distinctive V-shape at the rear end. When disturbed, the larvae wiggle frantically or rapidly attach a silken line to a leaf and drop over the edge. Larvae feed mostly on outer or older leaves of older plants, chewing out small holes, or at the growing points of young plants. They also feed on floral stalks and flower buds.

Adult moths are small, slender, and grayish brown. Male moths display three diamond-shaped markings on their back. In the Pacific Northwest, the damage from diamondback moth is not so much from feeding as from contamination by pupae. Late stage instars crawl into stems infesting harvested crops.

**Biology and life history** Cabbage is the preferred host, but it also attacks all cole family crops. The adult overwinters in trash in and around fields. Adults emerge in May and early June and lay eggs singly or in twos or threes mainly on the upper sides of leaves. The eggs are minute. They hatch in 4 to 8 days. Larvae feed mostly on the undersides of outer or older leaves of older plants, chewing out small holes, and mature in 10 to 30 days. They then spin loose white cocoons, which they attach to leaves or stems, and pupate within them. Adults emerge in 10 to 14 days. There may be two to four overlapping generations each year.

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

In Minnesota, the action thresholds for diamondback moth in cabbage are: Where diamondback moth is the primary insect pest (usually early-year), before cupping, treat with *Bacillus thuringiensis* if 50% of plants are infested with five or more larvae each. After cupping, treat if 10% of plants are infested with one or more larvae each.

### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, consider the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on kale.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5-B) at 0.014 to 0.035 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin)—See product labels for rates. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution. Spray to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 14 days. REI 12 hr. Limit 4 treatments per year. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days.
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/A as soil, chemigation or foliar treatment. PHI 3 days. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 3 days foliar, 10 days drip chemigation. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 14 days. REI 12 days. Do not exceed 92 lb ai/A per season. Collards only. OMRI-listed for organic use. Product not registered for use in OR.
- cyantraniliprole (Exirel) at 0.045 to 0.88 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Limit 3 treatments per crop. Retreatment interval 5 days. Do not exceed 0.22 lb ai/A per year. Product not registered for use in WA.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.06 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/A per crop. Limit 5 treatments per year. Retreatment interval 3 days.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval kale 5 days, collards 7 days. Limit 3 applications.
- methomyl (Lannate SP) at 0.45 lb ai/A. PHI 10 days. REI 48 hr. Do not exceed 5.4 lb ai/A collards per year. Fresh market Collards only.
- naled (Dibrom 8E) at 0.94 lb ai/A. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Do not exceed 9.4 lb ai/A per year.

- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per year. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.023 to 0.062 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. Entrust SC is OMRI-listed for organic use.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/A per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Collard and kale—Flea beetle

**Includes** cabbage flea beetle (*Phyllotreta cruciferae*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours.

Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 feet of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

### Management—cultural control

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on kale.
- imidacloprid
- kaolin—When applied as a spray to foliage it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Do not use on kale. Not registered for use in OR.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin as a foliar application. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.

- carbaryl (Sevin XLR Plus) at 0.5 to 1 lb ai/A. PHI 14 days. REI 12 hr. Limit 4 treatments per year. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/A foliar, 0.15 to 0.2 lb ai/A soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/A per season.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Limit 3 treatments per crop. Retreatment interval 7 days. Do not exceed 0.22 lb ai/A per year. Product not registered for use in WA.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 92 lb ai/A per season. Some formulations are OMRI-listed for organic use. Collards only. Product not registered for use in OR.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year. Limit 6 treatments per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per year.
- dinotefuran (Venom) at 0.088 to 0.131 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.263 lb ai/A per season. Retreatment interval 7 days. Limit 3 treatments.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 7 days. REI 12 hr. Do not feed crop residue. Apply at ground level only. Do not exceed 0.2 lb ai/A per year. Collards only.
- imidacloprid (Admire Pro) at 0.047 lb ai/A for foliar application. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/A per year.
- imidacloprid (Prey 1.6) at 0.0475 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/A per year.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval kale 5 days, collards 7 days. Limit 3 applications.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/A. Soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/A per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Collard and kale—Imported cabbageworm

*Pieris rapae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** The following information is from California but is generally applicable in the Pacific Northwest: Cabbageworms can be monitored at the same time as cabbage loopers. Sample 25 plants selected randomly throughout the field. Although treatment levels combine the two species, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant, often near the midribs of leaves. Good clues to cabbageworm presence include their greenish brown fecal pellets or many white cabbage butterflies fluttering around the field (check for eggs in a few days).

Base treatment on numbers of healthy larvae present. Treat seedlings or small plants if populations of medium-sized to large caterpillars are high enough to stunt growth. Treatment prior to harvest is necessary to prevent contamination for harvested product.

### Management—biological control

Natural enemies can assist significantly in the control of imported cabbageworm. Important parasites include the pupal, larval, and egg parasites in the *Trichogramma* genus, as well as tachinid flies. Timely mass releases of commercially available trichogramma during peak flight can be an effective control agent. Viruses and bacterial diseases are also sometimes important control factors in the field.

Where possible, use *Bacillus thuringiensis* (*Bt*) to avoid adverse impact on natural enemies. *Bt* is very effective against imported cabbageworm, especially when applied to young (early-instar) caterpillars.

### Management—cultural control

Make new plantings as far as possible from those of the previous year. At the end of the year, harvest crops without delay. Plowing under or destroying plant residues at this time eliminates an important food source for the overwintering generation of cabbageworms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin

- esfenvalerate—Do not use on kale.
- kaolin—When applied as a spray to foliage it acts as a repellent to some insect pests. Some formulations OMRI-listed for organic use. Do not use on kale. Not registered for use in OR.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- *Bacillus thuringiensis* (Javelin) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/A beta-cyfluthrin or 0.2 lb ai/A imidacloprid per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/A imidacloprid and 0.24 lb ai/A bifenthrin. Retreatment interval 7 days. Maximum 5 treatments only after bloom.
- bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution. Spray to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 14 days. REI 12 hr. Limit 4 treatments per year. Do not exceed 6 lb ai/A per crop. Retreatment interval 7 days.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A as soil, chemigation or foliar treatment. PHI 3 days. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 3 days foliar, 10 days drip chemigation. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 92 lb ai/A per season. Some formulations are OMRI-listed for organic use. Collards only. Product not registered for use in OR.
- cyantraniliprole (Exirel) at 0.045 to 0.88 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/A per year. Limit 6 treatments per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Limit 3 treatments per crop. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per year. Product not registered for use in WA.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/A per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/A per year.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.06 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 7 days. REI 12 hr. Do not feed crop residue. Do not exceed 0.2 lb ai/A per year. Collards only.
- flubendiamide/buprofezin (Vetiva) at 0.21 to 0.42 lb ai/A. PHI 1 day. REI 12 hr. Limit 2 treatments. Retreatment interval 7 days. Do not exceed 0.83 lb ai/A per year. Not registered for use in OR, or kale or collards in WA.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/A per crop. Limit 4 treatments per year. Retreatment interval 3 days.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval kale 5 days, collards 7 days. Limit 3 applications.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/A, Rates vary between kale and collards; see label. PHI 10 days. REI 48 hr. Do not exceed 5.4 lb ai/A for collards per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/A for early-season application or at 0.12 to 0.16 lb ai/A for mid- to late-season application. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/A per season.
- naled (Dibrom 8E) at 0.94 lb ai/A. PHI 1 day. REI 48 hr. Do not exceed 9.4 lb ai/A per year. Retreatment interval 7 days
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. Entrust SC is OMRI-listed for organic use.

- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early-year; 0.12 lb ai/A mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/A per application or 0.625 lb ai/A per year. Retreatment interval 10 days. Use of a surfactant is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/A applied to the soil. PHI 30 days. REI 12 hr. Do not 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/A per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season.

## Collard and kale—Leafminer

### Includes

Cabbage leafminer (*Liriomyza brassicae*)

Pea leafminer (*Liriomyza huidobrensis*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long, stiff bristles. Larvae are nearly translucent white or yellow and about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups.

Both larvae and adults cause damage to plants. Larval feeding results in slender, winding trails on the leaves, which form large, white blotches when mining becomes severe. Adults can make as many as 100 feeding punctures on a single leaf. Around 5% of these punctures may contain actively feeding larvae. Excessive mining renders leaves unmarketable, reduces photosynthetic capacity, and provides easy access for disease organisms.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- esfenvalerate—Do not use on kale.
- kaolin—When applied as a spray to foliage it acts as a repellent to some insect pests. Some formulations OMRI-listed for organic use. Do not use on kale. Not registered for use in OR.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/A per season. Adults only.
- azadirachtin (Neemix 4.5) at 0.14 to 0.25 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Not registered for use in OR.
- clothianidin (Belay) at 0.15 to 0.2 lb ai/A soil. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Suppression only.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/A per year. Add appropriate adjuvant.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/A. REI 4 hr. PHI 1 day. Limit 3 treatments per crop. Retreatment interval 7 days. Do not exceed 0.16 lb ai/A per year. Product not registered for use in WA.
- cyromazine (Trigard) at 0.125 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed six applications or 0.75 lb ai/A per crop. Retreatment interval 7 days.
- dimethoate (Dimethoate 4EC, Dimethoate LV-4) at 0.25 lb ai/A. PHI 14 days. REI 48 hr. Kale only. Do not exceed 0.5 lb/A per season. Retreatment interval 15 days.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.06 lb ai/A per season. Retreatment interval 7 days. Do not graze.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/A per season. Follow resistance management procedures on the label. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success) at 0.0625 to 0.156 lb ai/A. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/A per crop. Use a spray adjuvant for leafminers and thrips. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/A per season. Adult leafminers only.

## Collard and kale—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone II)—Preplant incorporation.
- diazinon (Diazinon AG500)—Broadcast just before planting at 3 to 4 lb ai/A, and immediately incorporate into the top 4 to 8 inches of soil. REI 4 days.

## Corn, sweet—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description and crop damage** The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Green peach aphid infestations may result in wilting. The potato aphid has both a pink and green form. It is a larger aphid. High potato aphid populations can distort leaves and stems, stunt plants, and cause necrotic spots on leaves. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit. The bean aphid is dark olive green to black with light-color legs. It is usually more of an early year pest.

Aphids may become very abundant on leaves, tassels, and ear-silk, especially in eastern Oregon. Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases such as alfalfa mosaic, tomato yellow top, and zucchini yellow mosaic (a large number of viruses are spread by aphids).

There is some evidence that severe infestation of ear-silk reduces tip fill, but this needs further evaluation. In fresh market corn, the most serious problem caused by aphids is contamination of the harvested ears.

### Biology and life history

See:

Common Pests of Vegetable Crops

**Pest Monitoring** A specific action threshold for aphid control in sweet corn has not been established in the PNW. The need for aphid control depends on whether the corn is being grown for processing or fresh market. There is very little tolerance for aphid contamination or honeydew in the corn silk of fresh market sweet corn. Although aphid populations can be dramatic, treatments for aphids in commercial sweet corn for processing are rare.

If aphids become numerous, increase frequency of sampling. Begin controlling significant aphid infestations in fresh market corn prior to silking. Aphids often are concentrated in hot spots or near the field margin. Infestations frequently are localized, with heavily infested leaves curled downward. Note the presence of any hot spots but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not in a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

Sweet corn for processing can tolerate higher levels of aphid pressure before treatment is required, because the husks and eartips are removed in the processing plant. In most cases, natural enemies provide adequate control of aphids in processing sweet corn.

### Management—cultural control

Destroy aphid-infested crops growing next to maturing sweet corn plantings immediately after harvest to prevent dispersal. Destroying weed hosts

late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen.

*Home gardeners* can often get effective control by washing aphids with a strong stream of water.

#### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- efenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- lambda-cyhalothrin
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acetamprid (Assail 30SG) at 0.04 to 0.054 lb ai/A. PHI 1 day. REI 12 hr. Limit 4 treatments per year. Retreatment interval 7 days. Do not exceed a total of 0.21 lb ai/A per growing season.
- alpha-cypermethrin (Fastac EC) at 0.018 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin—See label for application rates. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- bifenthrin (Capture LFR) at 0.033 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Suppression only. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic production
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.45 lb ai/A per year.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- flupyradifurone (Sivanto 200SL) at 0.091 to 0.137 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/A. PHI 1 day. REI 24 hr. Do not graze. Do not exceed 0.24 lb ai/A per season.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/A product. Retreatment interval 3 to 10 days. Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Retreatment interval 4 days. Do not harvest for feed or graze livestock for 21 days.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. No longer registered for use in WA.
- malathion (Malathion 5EC) at 1.0 lb ai/A. PHI 5 days. REI 12 hr. Retreatment interval 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.
- mineral oil—OMRI-listed for organic use.
- potassium laurate (insecticidal soap)—OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 3 to 5 days.

## Corn, sweet—Armyworm

### Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)

### **Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

**Pest Monitoring** The bertha armyworm is considered a “climbing cutworm” because it spends little time near the ground. It can be easy to miss while scouting, because though eggs and young instars tend to be clustered, later in the year they disperse actively. Larvae also drop quickly from plants when disturbed, avoiding detection. During outbreak years, populations can explode due to an influx of overlapping generations of migrating moths along with overwintering populations.

Pheromone traps are useful for determining when major flights occur, but not for predicting damage. There is currently no satisfactory, commercially available pheromone for bertha armyworm. If any moths are detected in pheromone traps, take a close look at the field during the following 2 weeks as eggs hatch and colonies of armyworm develop. A 5-minute timed search helps determine the need for treatment. On average, if one or more larvae or egg masses are found in 5 minutes, treatments may be justified.

In those rare instances when control measures are required, the beet armyworm is more difficult to control than the western yellowstriped armyworm. Insecticide applications are most effective if applied against small larvae.

### **Management—biological control**

Common natural enemies of armyworms include several braconid and ichneumonid wasps, many general predators including assassin bugs, damsel bugs, and spiders, and a nuclear polyhedrosis virus reported to have brought about excellent late year control in Canada. None of these natural enemies can be counted upon to achieve adequate control in any given year.

### **Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

### **Management—chemical control: HOME USE**

Armyworms are easier to control when small. Thus, it is good practice to keep close watch on plants and apply control measures against the immature larvae.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap (as a mix with spinosad) —Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- lambda-cyhalothrin
- permethrin
- plant derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

Armyworms are easier to control when small. Thus, it is good practice to use pheromone traps to anticipate egg deposition and hatch, and to keep close watch on fields and apply control measures against the immature larvae.

- azadirachtin—See label for application rates. Some formulations are OMRI-listed for organic use.
- alpha-cypermethrin (Fastac EC) at 0.018 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- *Bacillus thuringiensis* (Javelin WG) 0.12 to 1.5 lb/A. PHI 0 days. REI 4 hr. Armyworms only. Use a spreader-sticker to enhance control. Some formulations are OMRI-listed for organic use.
- bifenthrin (Capture LFR) at 0.04 to 0.16 lb ai/A at planting; 0.047 to 0.062 lb ai/A pre-plant incorporated; 0.04 lb ai/A pre-emergence; 0.033 to 0.1 foliar. PHI 1 day for foliar. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/A. PHI 1 days. REI 24 hr (Varies based on crop use; refer to label). Do not exceed 0.2 lb

- ai/A per year. Product not registered for use in WA.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed a total of 0.22 lb ai/A per growing season.
- borate complex (Prev-Am) applied as a 0.8% solution. Apply to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 2 days for harvest of ears, 14 days for forage, or 48 days for fodder. REI 24 hr. Do not exceed 16 lb ai/A per year. Retreatment interval 3 days. Limit 8 treatments per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 1 day. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 1 day. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.059 to 0.98 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic production.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.45 lb ai/A per year.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/A. REI 24 hr. PHI 1 day. Do not graze. Do not exceed 0.24 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Retreatment interval 4 days. Do not harvest for feed or graze livestock for 21 days.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. Product not registered for use in WA.
- malathion (Malathion 5EC) at 1.0 lb ai/A. PHI 5 days. REI 12 hr, dependent on activity; refer to label for REI. Retreatment interval 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.
- methoxyfenozide (Troubadour 2F) at 0.06 to 0.25 lb ai/A. PHI 3 days for ears or forage, and 21 days for dry fodder. REI 4 hr. Do not exceed 1 lb ai/A per season. An adjuvant will improve performance. Retreatment interval 5 days.
- novaluron (Rimon 0.83 EC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.39 lb ai/A per season.
- permethrin (Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.45 lb ai/A per year.
- spinetoram (Radiant SC) at 0.023 to 0.0469 lb ai/A. PHI 1 day for ears, 3 days for forage. REI 4 hr. Retreatment interval 2 days. Do not exceed six applications or 0.281 lb ai/A per season. Follow resistance management procedures on the label.
- spinosad (Success, Entrust SC) at 0.023 to 0.094 lb ai/A. PHI 1 day for ears, and 7 days for forage. REI 4 hr. Do not exceed 0.45 lb ai/A per year. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 7 days for grain, stover & forage. REI 12 hr. Do not exceed 0.2 lb ai/A per season.

## Corn, sweet—Corn earworm

*Helicoverpa zea*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest Monitoring** Moths can be sampled with pheromones placed in inverted cone-type traps. A first application of insecticide is made at first silk regardless of moth counts. The presence of five to ten moths per night per trap may be considered a tentative action threshold for additional sprays.

Fresh-market corn has very little tolerance of earworms. Earworm becomes a problem in processing sweet corn when the larvae penetrate deeply into the ear. A single application at first silk during intense moth egg laying events may be justified for processing sweet corn.

Once larvae enter the corn ears, control with insecticides is very difficult. It depends on proper timing and thorough coverage. Begin sampling at first visible silk. The presence of large numbers of eggs on fresh corn silks indicates the potential for damaging populations. Begin treatments during silking stage, at the start of egg hatch. Direct insecticidal control towards young larvae that are feeding on the exposed ear tips.

### Management—biological control

Many predators and parasites attack corn earworm eggs, including several species of Trichogramma. Most parasitized eggs turn black, but there may be a lag period before they do so. Commercial releases of trichogramma wasps have been used with mixed results. Generalist predators such as lacewings, minute pirate bugs, and damsel bugs feed on corn earworm eggs and small larvae.

### Management—cultural control

In sweet corn, very early plantings often escape significant damage compared with late-season corn, because earworm population densities increase as the season progresses. Some varieties of corn seem to suffer more corn earworm damage than others. These include varieties with tight husks like

'Country Gentleman,' 'Golden Security,' 'Silvergent,' and 'Staygold.' A clothespin placed at the point where the silk enters the ear can prevent earworm access. Plow or dig up plants in the fall to prevent overwintering.

### Management—chemical control: HOME USE

Apply when silks first appear. Repeat three to four times as label allows. Direct insecticide application to silk.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- delatamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- azadirachtin—See label for application rates. Some formulations are OMRI-listed for organic use.
- alpha-cypermethrin (Fastac EC) at 0.018 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed a total of 0.22 lb ai/A per growing season.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- borate complex (Prev-Am) applied as a 0.8% solution. Apply to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- bifenthrin (Capture LFR) at 0.033 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 2 days for harvest of ears, 14 days for forage, 48 days for fodder. REI 24 hr. Retreatment interval 3 days. Limit 8 treatments per year. Do not exceed 16 lb ai/A per crop.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 1 day. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 1 day. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed 0.44 lb ai/A per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/A. PHI 1 day. REI 12 hr. Do not apply more than 0.45 lb ai/A in one growing season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb/A. PHI 1 day. REI 24 hr. Do not graze. Do not exceed 0.24 lb ai/A per season.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/A for application through tassel push only. PHI 3 days; 35 days for fodder & stover. REI 12 hr. Limit 4 treatments per season. Do not exceed 0.26 lb ai/A per crop.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Retreatment interval 4 days. Do not harvest for feed or graze livestock for 21 days.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. Product not registered for use in WA.
- malathion (Malathion 5EC) at 1.0 lb ai/A. PHI 5 days. REI is 72 hr for detasseling and 12 hr for all other activities. Retreatment interval 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.3 to 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.
- mineral oil—Apply direct to silk. OMRI-listed for organic use.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.39 lb ai/A per season.
- permethrin (Pounce 25WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed and 0.8 lb ai/A for Pounce per season.
- polyhedral occlusion bodies (Gemstar LC) at 4 to 10 fl oz formulated product per acre. PHI 0 days. REI 4 hr. Retreatment interval 2 days. OMRI-listed for organic production.
- spinetoram (Radiant SC) at 0.023 to 0.0469 lb ai/A. PHI 1 day for ears, 3 days for forage. REI 4 hr. Retreatment interval 2 days at silking.

Do not exceed six applications or 0.281 lb ai/A per season. Follow resistance management procedures on the label.

- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 1 day for ears, 7 days for forage. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/A per crop. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 3 days for grain, stover & forage. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 3 to 5 days.

## Corn, sweet—Corn rootworm (adult)

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

**Pest description and crop damage** The adult of the corn rootworm, also known as the western spotted cucumber beetle, is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white, except for the head and last abdominal segment, which are brown. They are about 0.62 inch long. The larvae appear to have two heads.

Corn rootworm adults eat small holes in the leaves of emerging corn plants. They lay their eggs at the base of emerging corn plants. Larvae attack the roots of the corn seedlings. Occasionally, larvae cause significant stand losses in early corn plantings. Adults feed on corn silk and may have an impact on pollination, though this has not been evaluated fully in the PNW.

**Pest Monitoring** It is rare to treat emerging sweet corn to prevent foliar damage by adults. However, if adult feeding damage is observed in emerging sweet corn, this may indicate significant egg laying pressure. If this occurs at corn emergence in an unprotected corn planting, post-emergence insecticide treatment may be justified. No action threshold has been established. Observations indicate that noticeable damage may occur to developing corn ears prior to harvest when populations reach two adult beetles per ear.

### Management—cultural control

*Home gardeners:* In most years, beetle populations diminish after egg laying and prior to the emergence of the summer population. Seeding can be delayed until after the beetles have dispersed and deposited most of their eggs. Individual beetles can be picked off.

### Management—chemical control: HOME USE

- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil— Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamprid (Assail 30SG) at 0.075 to 0.1 lb ai/A. PHI 7 day. REI 12 hr. Limit 2 treatments per year. Retreatment interval 14 days. Do not exceed a total of 0.21 lb ai/A per growing season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed a total of 0.22 lb ai/A per growing season.
- bifenthrin (Capture LFR) at 0.033 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- carbaryl (Sevin XLR Plus) at 1 to 2 lb ai/A. PHI 2 days for harvest of ears, 14 days for forage, 48 days for fodder. REI 24 hr. Do not exceed 16 lb ai/A per year. Retreatment interval 3 days. Limit 8 treatments per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/A. PHI 1 day. REI 12 hr. Do not apply more than 0.45 lb ai/A in one growing season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.02 to 0.04 lb ai/A (1 to 2 pints/A). PHI 0 days. REI 4 hr. Do not exceed 1.7 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Retreatment interval 4 days. Do not harvest for feed or graze livestock for 21 days.
- malathion (Malathion 5EC) at 1.0 lb ai/A. PHI 5 days. REI 72 hr if detasseling, 12 hr for all other activity. Retreatment interval 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.

- permethrin (Pounce 25WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.8 lb ai/A Pounce per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 3 to 5 days.

## Corn, sweet—Corn rootworm (larvae)

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

**Pest description and crop damage** The western spotted cucumber beetle is the primary species of corn rootworm in the Pacific Northwest. It is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white except for the head and last abdominal segment, which are brown. They are about 0.62 inch long. The larvae appear to have two heads.

Corn rootworm larvae feed on roots and bore into the base of stems, killing corn seedlings and reducing root mass in mature corn plants. Significant corn rootworm pressure can reduce plant establishment, reduce plant growth (due to root damage), and contribute to lodging of corn plants prior to harvest.

**Pest Monitoring** No action threshold has been established in the PNW. If significant numbers of adult beetles are observed feeding and laying eggs in unprotected sweet corn plantings at emergence, this may justify a postemergence insecticide treatment.

### Management—chemical control: HOME USE

- bifenthrin (as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus amyloliquefaciens* (Ethos XB) at 0.08 to 0.2 lb ai/A applied with liquid fertilizer at plant. REI 12 hr.
- bifenthrin (Capture LFR) at 0.08 to 0.2 lb ai/A banded or over furrow. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/IBA (Empower 2) at 0.002 to 0.006 lb ai/1,000 linear row ft at plant. PHI 18 days. REI processed sweet corn 24 hr, fresh market 18 days. Do not exceed 0.2 lb ai/A at plant application. Not registered for use in OR.
- chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.40 to 0.47 oz ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches.
- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel seed treatment. Not for use in hopper-box, slurry-box, or similar applications. Use in liquid or slurry treaters.
- ethoprop (Mocap 15G) at 0.99 lb ai/A at plant, with 40 inch row spacing. Mocap 15G rate depends on row spacing; see label. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Applied as a band on row or closed seed furrow, or as side-dress from planting to lay-by. Do not contact seed.
- gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft. PHI 21 days. REI 24 hr. Do not exceed 0.024 lb ai/A.
- *Isaria fumosorosea* Apopka Strain 97 (PFR-97) at 1 to 2 lb/A of product as soil treatment. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 ft of row soil treatment. REI 24 hr. Do not harvest for feed or graze livestock for 21 days. Do not exceed 0.48 lb ai/A per season.
- phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft. PHI (see label). REI (see label). Apply at planting time or cultivation. Do not exceed 1.3 lb ai/A per year. Limit 1 treatment per year.
- tefluthrin (Force 3G) at 0.0075 to 0.011 lb ai/1,000 ft row (0.12 to 0.15 oz ai/1,000 ft row). REI 48 hr. Use either at planting or lay-by. Only one application per year.
- thiamethoxam/Abamectin (Avicta Complete Corn 250)—Seed treatment for certified seed treatment facilities only.

## Corn, sweet—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest Monitoring** Pheromone traps can be used to monitor for cutworms, but use them in combination with field scouting. Pheromone traps capture male moths only. Following a particularly mild winter, gravid (pregnant) females overwinter in field boundaries and can infest corn plantings undetected by pheromone traps.

Pheromone moth trap counts in excess of two black cutworm moths per trap per day indicate significant egg-laying pressure. It is useful to check moth counts prior to making a pesticide application decision at planting. When significant (greater than two moths per trap per day) moth counts are detected, intensify your field scouting during crop emergence.

Since extensive damage may occur in a short period of time, inspect new sweet corn plantings frequently. Check sweet corn fields at emergence. If a black cutworm infestation is caught early, post-plant insecticide applications can rescue an unprotected planting. Frequently, the damage is most serious at the edges of a field but stand loss can occur in a spotty pattern throughout the field. Usually, it is necessary to dig in the soil to find black cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved. Larvae normally hide in the soil around the base of the corn seedling or under debris on the soil surface during the day. They are active, voracious feeders at night.

In North Carolina, an economic threshold of 5% injured plants has been established for cutworm infestation of corn plantings during the first 3 weeks after establishment. In Ontario, Canada, the guideline for black cutworm on many seedling vegetables is also 5% plants infested. In Nebraska, in field corn, scouting begins soon after emergence and continues through the four-leaf stage, at least every 3 days.

#### **Management—biological control**

Black cutworm populations vary dramatically from year to year. Variation in cutworm populations is caused by overwinter survival, which is regulated by weather, natural enemies, and disease in the cutworm population.

Cutworms are attacked by a number of predators, parasites, and diseases. Many of these natural control agents are not effective on pale western and black cutworms because of their subterranean nature. It is not known if any of these natural enemies can control cutworm populations completely, but their presence should be noted and taken into consideration when making a pesticide application decision.

Several strains and products of *Bacillus thuringiensis* (*Bt*) are available. Early-season sampling, detection, and treatment when the larvae are small are critical steps to successful results with these products. Larvae half-grown or smaller are most susceptible. Crops with dense foliage require the higher label rates. Evening applications and a suitable spreader-sticker contribute to success. Not effective on subterranean cutworms.

#### **Management—cultural control**

Cutworms are most injurious in weedy fields with high plant residue and weedy field boundaries. Organic sweet corn plantings are especially susceptible to black cutworm infestations due to these factors. Clean tillage and clean field boundaries reduce risk of black cutworm damage by removing overwintering sites. Historically, cutworms are a problem in early, spring-seeded fields. Tillage prior to seeding may reduce cutworm populations. A thorough harrowing between established plantings may reduce cutworm damage.

#### **Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

#### **Management—chemical control: HOME USE**

Apply any one of these materials to the soil surface at first sign of cutworm activity, as allowed by label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help. Beans, tomatoes, and late corn are most often “hoed” by cutworms. Attack varies in severity with locality and year.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- kaolin—When applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- permethrin
- plant derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- azadirachtin—See label for application rates. Some formulations are OMRI-listed for organic use.

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- *Bacillus thuringiensis* (Javelin WG, XenTari) at 0.12 to 1.5 lb/A Javelin WG, and 0.5 to 1.5 lb/A of XenTari. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed a total of 0.22 lb ai/A per growing season.
- bifenthrin (Capture LFR) at 0.04 to 0.16 lb ai/A at planting; 0.047 to 0.062 lb ai/A pre-plant incorporated; 0.04 lb ai/A pre-emergence; 0.033 to 0.1 lb ai/A foliar. PHI 1 day for foliar. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/IBA (Empower 2) at 0.002 to 0.006 lb ai/1,000 linear feet of row. PHI 18 days. REI 24 hr, or 18 days if going to fresh market. Do not exceed 0.1 lb ai/A at plant application. Not registered for use in OR.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A. PHI 2 days for harvest of ears, 14 days for forage, or 48 days for fodder. REI 12 hr. Retreatment interval 3 days. Limit 8 treatments per year. Do not exceed 16 lb ai/A per year.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.40 to 0.47 oz ai/1,000 row ft. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches.
- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel seed treatment. Not for use in hopper-box, slurry-box or similar applications. Use in liquid or slurry treaters.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.013 to 0.044 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed 0.44 lb ai/A per season.
- deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/A. PHI 1 day. REI 12 hr. Do not apply more than 0.45 lb ai/A in one growing season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- ethoprop (Mocap 15G) at 3 lb ai/A before planting to at-plant. Incorporate. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches.
- gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft at planting or 0.01 to 0.015 lb ai/A foliar application. PHI 1 day. Do not exceed 0.24 lb ai/A total application per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A broadcast. PHI 1 day. REI 24 hr. Do not harvest for feed or graze livestock for 21 days. Retreatment interval 4 days. Do not exceed 0.48 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 ft of row soil treatment. REI 24 hr. Do not harvest for feed or graze livestock for 21 days. Do not exceed 0.48 lb ai/A per season.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. Not registered for use in WA.
- methomyl (Lannate SP) at 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.
- permethrin (Pounce 25WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.8 lb ai/A Pounce per season.
- permethrin (Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 3 to 7 days; refer to label. Do not exceed 0.45 lb ai/A per year.
- tefluthrin (Force 3G) at 0.0075 to 0.011 lb ai/1,000 row ft (0.12 to 0.15 oz ai/1,000 row ft). REI 48 hr. Use either at planting or lay-by. Only one application per year.
- thiamethoxam (Cruiser 5FS) at 0.125 to 0.80 mg per kernel (formulated product) planter box and seed treatment.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 3 to 5 days.

## Corn, sweet—Garden symphylan

*Scutigerella immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest Monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. In general, preplant field evaluation for symphylans involves grid sampling at one-acre intervals, digging 6 x 6 x 12-inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample. In Ohio, 50 to 100 symphylans per corn plant is considered damaging to early corn.

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

## Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with non-host crops has not been studied.

## Management—chemical control: HOME USE

- cyfluthrin

## Management—chemical control: COMMERCIAL USE

- chlorothoxyfos/bifenthrin (Smart Choice 5G) at 3 to 3.5 oz 1,000 row ft. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches.
- chloropicrin (Telone II)—Preplant.
- ethoprop (Mocap 15G) at 0.063 to 0.125 lb ai/A at plant. Rates for Mocap depend upon row spacing. Refer to label. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply as a band on row or closed seed furrow, or sidedress from planting to lay-by.

## Corn, sweet—Grasshopper

Several species

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

## Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants according to label instructions when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- insecticidal soap—Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- azadirachtin—See label for application rates. Some formulations are OMRI-listed for organic use.
- alpha-cypermethrin (Fastac EC) at 0.018 to 0.025 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed 0.22 lb ai/A per year.
- bifenthrin (Capture LFR) at 0.033 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A. PHI 2 days ears, 14 days forage, or 48 days fodder. REI 12 hr. Retreatment interval 3 days. Do not exceed 8 treatments. Do not exceed 16 lb ai/A per season.
- chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/A. PHI 1 day. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 1 day. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyfluthrin (Tombstone) at 0.031 to 0.044 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed 0.44 lb ai/A per season.
- deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.45 lb ai/A per year.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb/A. PHI 1 day. REI 24 hr. Do not graze. Do not exceed 0.24 lb ai/A per season.

- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. Not registered for use in WA.
- malathion (Malathion 5EC at 1.0 lb ai/A. PHI 5 days. REI 72 hr if detasseling, 12 hr for all other activity. Retreatment interval 5 days. Limit 2 treatments per year.
- novaluron (Rimon 083EC) at 0.039 to 0.078 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.39 lb ai/A per season.
- permethrin (Pounce 25WP) at 0.1 to 0.2 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed or 0.8 lb ai/A Pounce per season.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/A. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/A per season. Retreatment interval 3 to 5 days.

## Corn, sweet—Seedcorn maggot

*Delia platura*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest Monitoring** Slow emergence and poor stand establishment are signs of maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence increase susceptibility to maggot infestation.

In the Pacific Northwest, no specific monitoring methods have been developed. In other parts of the country, estimates of adult fly activity are obtained from the use of yellow or white sticky traps, water pan traps, and pyramid traps to assist in determining the necessity and timing of treatments. Treatments for seedcorn maggot are preventive. Consider them for fields that are high in organic matter or undecomposed organic material, or that have had previous maggot problems. To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply baker's yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult seedcorn maggot flies as they are attracted to carbon dioxide.

If you are planning to use untreated corn seed in a certified organic planting, sow a handful of seeds several places in the field, water, and flag them one week prior to your field planting date. Inspect the test seeds the day prior to planting the field. If 50-75% of the trial seeds are infested with seedcorn maggot, consider delaying or abandoning the sowing of untreated seed in the field for this growing season.

### Management—cultural control

Avoid planting in soils that are high in undecomposed organic matter, such as fields just coming out of pasture or that are very weedy. Use herbicides to kill cover crop strips 3 to 4 weeks before seeding. In soils amended with animal manures, allow adequate time for the manure to break down before planting, a minimum of 3 to 4 weeks. The smell of decomposing organic matter or manure attracts egg laying adult females. Avoid planting successive rotations of corn crops.

Early spring-planted crops are more likely to be damaged when the soil is too cool for rapid germination and emergence. If serious infestations are expected, wait until the soil warms up in spring. When planting, use a chain drag or similar implement behind the drill to cover the seed row. Consider planting into a "stale" seedbed. Use an appropriate insecticide in the seed box at planting if problems are expected.

### Management—chemical control: HOME USE

- bifenthrin (sometimes as a mix with zeta-cypermethrin).
- gamma-cyhalothrin
- lambda-cyhalothrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

#### *Seed treatment*

- imidacloprid (Gaucho 480F) at 0.125 to 0.5 to 1 oz ai/cwt of seed as a slurry treatment. Not registered for use in OR.
- permethrin + carboxin (Kernel Guard Supreme) at 1.5 oz of formulated product per 42 lb seed (2 oz per 56 lb seed). REI 12 hr. Planter box treatment. Not registered for use in WA.

#### *Soil treatment*

- *Bacillus amyloliquefaciens* (Ethos XB) at 0.08 to 0.2 lb ai/A applied with liquid fertilizer at plant. REI 12 hr.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/A soil application. REI 12 hr. Do not exceed a total of 0.22 lb ai/A per growing season.
- bifenthrin (Capture LFR) at 0.04 to 0.16 lb ai/A at planting; 0.047 to 0.062 lb ai/A pre-plant incorporated. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/IBA (Empower 2) at 0.002 to 0.006 lb ai/1,000 linear feet of row. PHI 30 days. REI 24 hr. Do not exceed 0.1 lb ai/A at plant application. Not registered in OR.
- chlorothoxyfos/bifenthrin (Smart Choice 5G) at 3 to 3.5 oz /1,000 row ft. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches.
- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel seed treatment. Not for use in hopper-box, slurry-box or similar types. Use in liquid or slurry treaters.

- cyfluthrin (Tombstone) at 0.031 to 0.44 lb ai/A soil treatment. PHI 0 days. REI 12 hr.
- gamma-cyhalothrin (Declare) at 0.0008 lb ai/1,000 row ft. REI 24 hr. Do not exceed 0.024 lb ai/A.
- lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 ft of row soil treatment. REI 24 hr. Do not harvest for feed or graze livestock for 21 days. Do not exceed 0.48 lb ai/A per season.
- phorate (Thimet 20G) at 0.9 to 1.2 oz ai/1,000 row ft. PHI (see label). REI (see label). Apply at planting time or cultivation. Do not exceed 1.3 lb ai/A per year. Limit 1 treatment.
- tefluthrin (Force 3G) at 0.0075 to 0.011 lb ai/1,000 row ft (0.12 to 0.15 oz ai/1,000 row ft). REI 48 hr. Use either at planting or lay-by. Only one application per year.
- thiamethoxam (Cruiser 5FS) at 0.125 to 0.80 mg per kernel (formulated product) planter box treatment, seed treatment.
- thiamethoxam/Abamectin (Avicta Complete Corn 250). Seed treatment for certified seed treatment facilities only.

## Corn, sweet—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laevis*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron (ferric) phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- sodium ferric EDTA

### Management—chemical control: COMMERCIAL USE

- iron phosphate (Sluggo Snail and Slug Bait) at 0.24 to 0.44 lb ai/A (24 to 44 lb/A). Consult label for REI and PHI.
- metaldehyde baits. Do not contaminate edible plant parts. Use as needed but not more than once per week.

## Corn, sweet—Spider mite

Several species

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest Monitoring** Infestations usually begin on lower leaves of plants, then progress upwards. Inspect lowest leaves for stippling and webbing first.

### Management—biological control

Spider mite populations are held down in cool conditions early in the season by various predators such as pirate and big-eyed bugs. Predator mites are effective predators of spider mites and are available.

### Management—cultural control

Avoid early season applications of broad spectrum insecticides, which will reduce populations of beneficial insects. Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. Mites can be hosed from plants with a strong stream of water. Excessive nitrogen fertilization may cause population buildup.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- insecticidal soap—Apply control measures when mites first appear, and repeat application as necessary. Thorough coverage, especially of

undersides of leaves, is essential. Some formulations are OMRI-listed for organic use.

- horticultural oil—Some formulations are OMRI-listed for organic use.
- plant essential oils (clove, garlic etc.)—Some formulations are OMRI-listed for organic use.
- sulfur (as a mix with pyrethrins) —Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-MekSC) at 0.0095 to 0.019 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.038 lb ai/A per year. Organosilicone surfactant improves translaminar movement.
- bifenthrin (Capture LFR) at 0.1 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/A per season.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- borate complex (Prev-Am) applied as a 0.8% solution. Apply to complete coverage. REI 24 hr. Retreatment interval 7 days. OMRI-listed for organic use
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic production.
- hexythiazox (Onager) at 0.094 to 0.188 lb ai/A. PHI 28 days. REI 12 hr. Do not exceed 0.188 lb ai/A per year.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/Acre of product. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr (dependent on rainfall; consult label). Apply at planting time or cultivation. Do not exceed 1.3 lb ai/A per year. Limit 1 treatment.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 fl oz product per 100 gal. REI 4 hr.
- propargite (Comite) at 1.6 to 2.4 lb ai/A. PHI 30 days. REI 13 days. Apply before ears form.
- spiromesifen (Oberon 2SC) at 0.089 to 0.25 lb ai/A. PHI 5 days, depending on end use. REI 12 hr. Retreatment 14 days. Do not exceed 0.27 lb ai/A per season. Limit 2 treatments per year.

## **Corn, sweet—Thrips**

### **Includes**

Corn thrips (*Frankliniella williamsi*)

Western flower thrips (*Frankliniella occidentalis*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- gamma-cyhalothrin
- horticultural oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- malathion
- mineral oil—Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel seed treatment. Not for use in hopper-box, slurry-box or similar types. Use in liquid or slurry treaters.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic production.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb of product per acre. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/A. Harvest, feed and application restrictions; See label. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (Malathion 5EC) at 1.0 lb ai/A. PHI 5 days. REI 72 hr if detasseling, 12 hr for all other activity. Retreatment interval 5 days. Limit

2 treatments per year.

- methomyl (Lannate SP) at 0.23 to 0.45 lb ai/A. PHI 0 days for ears, 3 days for forage, and 21 days for stover. REI 48 hr. Do not exceed 6.3 lb ai/A per season.
- spinosad (Success, Entrust SC) at 0.0625 to 0.093 lb ai/A. PHI 1 day for ears, 7 days for forage. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/A per crop. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Entrust SC is OMRI-listed for organic use.

## Corn, sweet—Western bean cutworm

*Loxagrotis albicosta*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum pre-harvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help. Beans, tomatoes, and late corn are most often “hoed” by cutworms. Attack varies in severity with locality and year.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- kaolin—When applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use. Not registered for use in OR.
- permethrin
- plant derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin WG, XenTari) at 0.12 to 1.5 lb/A Javelin WG, and 0.5 to 1.5 lb/A of XenTari. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic production.
- beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/A soil application. PHI 0 days. REI 12 hr. Retreatment interval 2 days. Do not exceed 0.22 lb ai/A per year.
- bifenthrin/zeta-cypermethrin (Hero) at 0.04 to 0.1 lb ai/A. PHI 3 days. REI 12 hr. Retreatment interval 3 to 5 days. Do not exceed 0.266 lb ai/A per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 5 Bait) at 1 to 2 lb ai/A. PHI 2 days for harvest of ears, 14 days for forage, 48 days for fodder. REI 24 hr. Retreatment interval 3 days. Limit 8 treatments per year. Do not exceed 16 lb ai/A per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 1 day. REI 4 hr. Limit 4 treatments per crop. Retreatment interval 1 day. Do not exceed 0.2 lb ai/A per season.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.06 to 0.1 lb ai/A. PHI 1 day. REI 24 hr. Retreatment interval 1 day. Do not exceed 0.48 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/A per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic production.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/A. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.44 lb/A per season.
- esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/A. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/A per year. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft at planting or 0.01 to 0.015 lb ai/A foliar application. PHI 1 day. Do not exceed 0.24 lb ai/A total application per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. PHI 1 day. REI 24 hr. Do not exceed 0.48 lb ai/A per year. Do not harvest for feed or graze livestock for 21 days. Retreatment interval 4 days.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 to 0.16 lb ai/A. REI 19 days. PHI 21 days for ears & forage; 49 days for fodder. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin. Product not registered for use in WA.
- methoxyfenozide (Troubadour 2F) at 0.06 to 0.25 lb ai/A. PHI 3 days for ears or forage; 21 days for dry fodder. REI 4 hr. Do not exceed 1 lb

ai/A per season. An adjuvant improves performance. Retreatment interval 5 days.

- spinetoram (Radiant SC) at 0.023 to 0.0469 lb ai/A. PHI 1 day for ears, 3 days for forage. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.281 lb ai/A per season. Follow resistance management procedures on the label.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 1 day for ears, 7 days for forage. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/A per crop. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Entrust SC is OMRI-listed for organic use.

## Corn, sweet—Wireworm

*Ctenicera* spp. and *Limoni* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus amyloliquefaciens* (Ethos XB) at 0.08 to 0.2 lb ai/A applied with liquid fertilizer at plant. REI 12 hr.
- beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/A soil application. PHI 0 days. REI 12 hr. Do not exceed 0.22 lb ai/A per season.
- bifenthrin (Capture LFR) at 0.04 to 0.16 lb ai/A at planting; 0.047 to 0.062 lb ai/A pre-plant incorporated. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Toxic to bees and fish. Do not apply if rainfall is imminent. See label for other restrictions.
- bifenthrin/IBA (Empower 2) at 0.002 to 0.006 lb ai/1,000 row ft. PHI 30 days. REI 24 hr. Do not exceed 0.1 lb ai/A at plant application. Product not registered for use in OR.
- chlorethoxyfos/bifenthrin (Smart Choice 5G) at 3 to 3.5 oz /1,000 row ft or at 0.125 to 0.245 lb ai/A. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches.
- chloropicrin (Telone II)—Preplant incorporation.
- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel seed treatment. Not for use in hopper-box, slurry-box or similar types. Use in liquid or slurry treaters.
- cyfluthrin (Tombstone) at 0.031 to 0.44 lb ai/A soil treatment. PHI 0 days. REI 12 hr.
- ethoprop (Mocap 15G) at 0.063 to 0.125 lb ai/A at plant. REI 48 hr, or 72 hr if annual rainfall is less than 25 inches. Apply as a band on row or closed seed furrow. Do not apply within 140 ft of aquatic habitat.
- gamma-cyhalothrin (Declare) at 0.0004 lb ai/1,000 row ft. REI 24 hr. Do not exceed 0.024 lb ai/A.
- imidacloprid (Gaucho 480F) at 0.125 to 0.25 oz ai/100 lb of seed as a slurry treatment.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/Acre of product as soil treatment. REI 4 hr. Retreatment interval 3 to 10 days. Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 ft of row soil treatment. REI 24 hr. Do not harvest for feed or graze livestock for 21 days. Do not exceed 0.48 lb ai/A per season.
- permethrin + carboxin (Kernel Guard Supreme) at 1.5 oz of formulated product per 42 lb seed (2 oz/56 lb seed). REI 12 hr. Planter box treatment. Product not registered for use in WA.
- phorate (Thimet 20G) at 0.9 to 1.2 oz ai/1,000 row ft. REI 48 hr. Apply at planting time or cultivation. Do not exceed 1.3 lb ai/A per year. Limit 1 treatment.
- tefluthrin (Force 3G) at 0.12 to 0.15 oz ai/1,000 row ft (0.12 to 0.15 oz ai/1,000 row ft). REI 48 hr. In furrow is most effective when treating wireworm. With higher pressure use full 0.15 oz ai/1,000 ft rate. Use either at planting or lay-by. One application only per year.
- thiamethoxam (Cruiser 5FS) at 0.125 to 0.80 mg per kernel (formulated product) planter box treatment, seed treatment.

## Cucumber—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Melon aphid (*Aphis gossypii*)

Potato aphid (*Macrosiphum euphorbiae*)

### Pest description, crop damage and life history

See:

## Common Pests of Vegetable Crops

**Pest monitoring** Check plants frequently after transplant or seedling emergence. Aphid often are concentrated in “hot spots.” Be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor plants particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphid. Monitor the proportion of aphid mummies to unparasitized adults and the number of predators such as lady beetles. If the biocontrol agents appear to be gaining control, avoid sprays which would disrupt this system. Most products available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

*Home gardeners* can wash aphids from plants with a strong stream of water. Destroy infested plants immediately after harvest to prevent dispersal. Controlling weeds late in the season may help reduce overwintering populations. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. Row covers can be effective.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) 0.047 to 0.075 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- afidopyropen (Sefina Inscalis) at 0.01 lb ai/a. PHI 0 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix)—See label for rates. Acts slowly. Apply early. Thorough coverage and repeat applications are necessary. PHI 0 days. REI 4 hr.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr.
- bifenthrin (Brigade WSB, Sniper) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- borate complex (Prev-Am Ultra) applied as a 0.8% solution. Apply to complete coverage. REI 12 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar or 0.15 to 0.2 lb ai/a soil band, in-furrow, sidedress, drench, chemigation. PHI 7 days foliar,

21 days soil. REI 12 hr. Retreatment interval 10 days foliar. Do not exceed 0.2 lb ai/a per season.

- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day in field; 0 day in greenhouse. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a PHI 1 day. REI Limit 3 treatments. Do not exceed 0.22 lb ai/a per year Retreatment interval 5 days.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 days foliar, or 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days. Limit 3 treatments.
- flonicamid (Beleaf 50SG) at 0.002 to 0.003 lb ai/1,000 sq ft foliar or refer to label for soil treatment. Greenhouse only. PHI 0 days. REI 12 hr. Do not exceed 2 applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a foliar. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- flupyradifurone (Sivanto 200SL) at 0.27 to 0.37 lb ai/a soil. PHI 21 days. REI 4 hr. Do not exceed 0.365 lb ai/a per season regardless of application method. Maximum crop seasons per year: 3.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a or 0.0156 lb ai/10,000 plants (greenhouse). Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per season in-field or 0.0156 lb ai/10,000 plants (greenhouse). Limit 1 greenhouse treatment.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/a of product. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8) at 1.0 to 1.75 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 treatments.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a or 3 days if over 0.45 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per year.
- permethrin (Pounce 25W) at 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 1.2 lb ai/a per season. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season. Retreatment interval 7 days.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. Apply high rate for heavy infestations. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. See label for recommended in-row application instructions. Do not exceed 0.172 lb ai/a per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation. Platinum and Actara have the same active ingredient; for resistance management, do not follow one with the other.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil (suppression only). PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

#### Notes:

Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

Bees are important in cross-pollinating cucumbers. Take precautions to avoid poisoning them.

See:

How to Reduce Bee Poisoning from Pesticides

## Cucumber—Cucumber beetle

### Includes

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description and crop damage** The western spotted cucumber beetle is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white and about 0.62 inch long. The head and last abdominal segment are dark brown. A close relative, the western striped cucumber beetle, is yellowish and has three black lines down its back. The larvae live in the soil where they feed on roots, but adults are foliage and flower feeders. Cucumber beetle adults eat small holes in the leaves and flowers of many crops. Larvae feed on roots and bore into the base of stems.

**Biology and life history** Cucumber beetles overwinter as fertilized adults and are active beginning in early spring. Adults lay eggs at the base of plants. Eggs hatch in 7 to 10 days, and larvae feed in roots for about 3 weeks before pupating in the soil. Adults emerge in 2 weeks and begin feeding on pollen. As soon as they hatch, larvae begin to feed on plant roots. They complete their development in the soil. It takes 30 to 60 days to complete a life cycle. There are two generations a year.

**Pest monitoring** Specific treatment thresholds have not been established for these foliage feeders. Late-year infestations are insignificant. If numbers are damaging during mid-year, excessive foliage loss may reduce crop production. In Virginia, the recommendation is to prevent cucumber beetle damage to seedlings by treating when population reaches 1 beetle per 10 row ft.

#### **Management—cultural control**

Commercial row crop covers provide good protection from cucumber beetles, and in addition provide late frost protection and help in moisture retention. Sometimes, the timing of a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Delaying planting until warmer weather also gives crops a greater chance of outgrowing beetle injury. Trap crops sometimes can be used to draw beetles away from the main crop. Trap cropping is an unproven control method in Oregon.

#### **Management—chemical control: HOME USE**

Apply when beetles first appear and repeat at 7- to 10-day intervals as needed.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

#### **Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) 0.047 to 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.088 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin (Brigade WSB, Sniper) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/ zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- carbaryl (Sevin 4F) at 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per year. Phytotoxic under certain conditions.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar or 0.15 to 0.2 lb ai/a soil band, in-furrow, sidedress, drench, chemigation. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days foliar. Do not exceed 0.2 lb ai/a per season.
- cyfluthrin (Tombstone) at 0.038 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- cryolite (Kryocide) at 8 to 12 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 48 lb/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.

- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a. Soil application only. PHI 21 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8) at 1.75 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 treatments.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a or 3 days if over 0.45 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per year.
- novaluron (Rimon 0.83EC) at 0.06 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per year.
- permethrin (Ambush 25W, Pounce 25W) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 1.2 lb ai/a. Retreatment interval 7 days.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- thiamethoxam (Actara) at 0.047 to 0.086 lb ai/a. Suppression only. Apply high rates for heavy infestations. PHI 0 days. REI 12 hr. Minimum interval between treatments 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. Suppression only. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation. Platinum and Actara have the same active ingredient; for resistance management, do not follow one with the other.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (sometimes as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against cutworm. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb ai/a. PHI 0 days. REI 4 hr. Acts slowly. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.088 lb ai/a per season. Retreatment interval 7 days.

- bifenthrin (Brigade WSB, Sniper) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- carbaryl (Sevin 5 Bait) at 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per season. Limit 6 treatments per year.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Minimum of 5 days between applications. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.175 lb ai/a per season. Retreatment interval 7 days.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar; 21 day soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a as seedling spray. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- flubendiamide/buprofezin (Vetica) at 0.25 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 7 days. Do not exceed 0.79 lb ai/a per year.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8) at 1.75 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 treatments.
- methomyl (Lannate SP) at 0.45 lb ai/a. PHI 1 day at 0.45 lb ai/a or 3 days if over 0.45 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per year.
- permethrin (Pounce 25W, Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 1.2 lb ai/a foliar or 1.6 lb ai/a bait per season. Retreatment interval 7 days.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Garden symphylan

*Scutigerella immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. In general, preplant field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied.

**Management—chemical control: HOME USE**

- bifenthrin
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

**Management—chemical control: COMMERCIAL USE**

- chloropicrin (Telone)—Preplant.

## Cucumber—Grasshopper

Different species

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—chemical control: HOME USE**

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden when young hoppers or winged adults are seen.

- azarachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.088 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin (Sniper) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Do not make applications less than 7 days apart.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cryolite (Kryocide) at 8 to 12 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 48 lb ai/a per season.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.175 lb ai/a per season. Retreatment interval 7 days.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar; 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

# Cucumber—Looper

## Includes

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

**Pest description and crop damage** Cabbage looper adults are brownish moths with distinctive silvery figures on the front wings. Eggs are ridged and dome-shaped and usually laid singly on the undersurface of leaves. Loopers are smooth-skinned with only a few long bristles down the back. They are green, usually with a narrow white stripe along each side and several narrow lines down the back. They may grow up to 1.5 inches long. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Looper caterpillars can be distinguished from most other common caterpillars by their distinctive looping movement, in which they arch the middle portion of their body to bring the hind legs forward to meet the front legs. Cabbage looper larvae feed on leaves, causing ragged-edge holes in the leaf and on the leaf margins.

## Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- delamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly. Apply early. REI 4 hr. Retreatment interval 7 days. Thorough coverage and repeat applications are necessary.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.088 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin (Sniper) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Do not make applications less than 7 days apart.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution to complete coverage. REI 12 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a soil or foliar. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Minimum of 5 days between applications. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.065 to 0.133 lb ai/a. PHI 1 day in field; 0 day in greenhouse. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cryolite (Kryocide) at 8 to 12 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 48 lb ai/a per season. Some formulations are OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.175 lb ai/a per season. Retreatment interval 7 days.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/a. PHI 7 days. REI 24 hr. PPE required. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per year.

- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- indoxacarb (Avaunt) at 0.045 to 0.11 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.44 lb ai/a per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a, 3 days if over 0.45 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.16 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/a per season. Do not exceed four applications per season. Adding a spreader-sticker improves performance.
- novaluron (Rimon 0.83EC) at 0.06 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per year.
- permethrin (Ambush 25W, Pounce 25W) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 1.2 lb ai/a per season. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments. Follow resistance management procedures on the label. Cabbage looper only.
- spinosad (Success, Entrust SC) at 0.063 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments. Entrust SC is OMRI-listed for organic use.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Seedcorn maggot

*Delia platura*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply bakers yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult seedcorn maggot flies as they are attracted to carbon dioxide.

### Management—chemical control: HOME USE

- bifenthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

### Seed treatment

- chlorpyrifos (Lorsban 50W) at 0.0625 lb ai per 100 lb of seed. Use as a slurry seed treatment prior to planting. Commercial seed treater only.

### Soil treatment

- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a in furrow with seed or transplant. REI 12 hr.
- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant broadcast, in-furrow or drench. REI 12 hr. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- thiamethoxam (Cruiser 5FS) consult label.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Slug

### Includes

Arion spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

*See:*

### Management—biological, cultural, tactical

See:

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

### Management—chemical control: COMMERCIAL USE

- iron phosphate (Leaf Life Sluggo Bait) at 0.20 to 0.44 lb ai/a (20 to 44 lb/a formulated product). PHI 0 days. REI 0 days.
- iron phosphate/spinosad (Bug-N-Sluggo) at 0.2 to 0.44 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days.
- metaldehyde baits—Do not contaminate edible plant parts. Use as needed but not more often than once per week.

## Cucumber—Spider mite

*Tetranychus* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Infestations usually begin on lower leaves of plants, then progress upwards. Inspect lowest leaves for stippling and webbing first.

### Management—cultural control

Avoid early season applications of insecticides, which will reduce populations of beneficial insects. Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. Excessive nitrogen fertilization may cause population buildup.

*Home gardeners* can wash plants with a strong stream of water.

### Management—biological control

Spider mite populations commonly are kept under control by predator mites. Spider mite outbreaks are not uncommon following an insecticide application for control of other insect pests. Release of commercially available predator mites to prevent spider mite outbreaks deserves further testing.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- insecticidal soap—Apply when mites first appear. Thorough coverage, especially to undersides of leaves, is essential. Some formulations are OMRI-listed for organic use.
- horticultural oil—some formulations are OMRI-listed for organic use.
- Plant-derived essential oils (such as clove, garlic and rosemary) have efficacy against spider mites. Some formulations are OMRI-listed for organic use.

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek EC, Epi-Mek 0.15EC) at 0.009 to 0.019 lb ai/a for low to moderate infestations and 0.019 lb ai/a for severe infestations. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit two sequential applications per season. Do not exceed 0.019 lb ai/application or 0.056 lb ai/a per year.
- acequinocyl (Kanemite 15SC) at 0.3 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per season.
- bifenazate (Acrامة 50WS) at 0.375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed one treatment per season.
- bifenthrin (Brigade WSB, Sniper) at 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin /avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- etoxazole (Zeal) at 0.09 to 0.135 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 1 treatment per season.
- geraniol/ citronellol/nerolidol/farnesol (Biomite) at 1 to 1.25 quarts/100 gal formulated product. REI 4 hr.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/a. PHI 7 days. REI 24 hr. PPE required. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per year.
- fenpyroximate (Miteus) at 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments per year. Do not exceed 0.21 lb ai/a per crop cycle.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/acre of product. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.03 lb ai/a (suppression only). PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- malathion (Fyfanon 8) at 1.0 to 1.75 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 treatments.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- pyridaben (Sanmite) at 0.188 to 0.28 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.56 lb ai/a per season. Limit 2 treatments. Retreatment interval 30 days. Greenhouse Only.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.4 lb ai/a per season. Retreatment interval 7 days. Limit 3 treatments.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Squash bug

*Anasa tristis*

**Pest description and crop damage** The squash bug attacks squash, pumpkin, melons, and related crops. Adults are typically dark brown, but may have gray or light brown markings. They are about 0.75 inch long at maturity. Squash bug nymphs and adults feed on the leaves, causing small yellow specks which later turn brown. Squash bugs also inject a toxin into vines, which causes a wilt from the point of attack to the end of the vine. Affected runners wilt and turn black and crisp. Small plants may be killed, while larger plants may lose several runners. Squash bugs also may attack young fruit.

**Biology and life history** Adult squash bugs overwinter in debris and sheltered places in the garden. Brown to reddish eggs are laid along the veins of new leaves. The newly hatched nymphs (immature bugs) are greenish to gray.

### Management—cultural control

Clean up debris in the fall to remove overwintering squash bugs. Hand-pick eggs, nymphs, and adults.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade WSB, Sniper) at 0.05 to 0.1 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Retreatment interval 7 days. Do not exceed 2 treatments after bloom.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a Athena, 0.056 lb ai/a avermectin, or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season. Limit 2 treatments after bloom.
- carbaryl (Sevin 4F) at 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per year. Do not apply to blooms.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.174 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.

- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar; 21 day soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per year.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

## Cucumber—Thrips

### Includes

Corn thrips (*Frankliniella williamsi*)

Western flower thrips (*Frankliniella occidentalis*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Biology and life history** Adults overwinter in trash, under bark, and in other protected places. Adults become active in the spring and lay eggs in the tissues of plants. The eggs hatch into nymphs, which begin feeding in flowers, buds, and leaves. When mature, nymphs drop to the ground and molt into adults. Under favorable conditions, a life cycle may require only 2 weeks.

**Pest monitoring** Treatment is usually not necessary on seedlings, because most plants recover from thrips injury. Foliage-feeding thrips also are beneficial at this time because they are effective predators on early year spider mite infestations. Both adult and immature thrips may be found in spider mite colonies feeding on spider mite eggs.

### Management—biological control

Minute pirate bugs play a major role in controlling thrips populations.

### Management—cultural control

Thrips populations tend to build up on weeds. Cultivating nearby weedy areas before the crop emerges reduces the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after crop emergence increases thrips problems.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (such as clove, garlic and rosemary)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.133 lb ai/a. PHI 1 day in field; 0 day in greenhouse. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year. Foliage feeding only.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a PHI 1 day. REI Limit 3 treatments. Do not exceed 0.22 lb ai/a per year Retreatment interval 5 days.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 days foliar, or 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- gamma cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a. Soil application only. PHI 21 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/acre of product. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- malathion (Fyfanon 8) at 1.0 to 1.75 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 treatments.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per year.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success, Entrust SC) at 0.09 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. A surfactant improves efficacy. Do not exceed 0.45 lb/a per year. Limit 6 applications. Entrust SC is OMRI-listed for organic use.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.18 lb ai/a lambda cyhalothrin or 0.48 lb ai/a tebuconazole per season. Retreatment interval 10 to 14 days.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil (suppression only). PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Cucumber—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a in furrow with seed or transplant. REI 12 hr.
- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant broadcast, in-furrow or drench. REI 12 hr. Do not exceed 0.35 lb ai/a per season.
- chloropicrin (Telone)—Preplant.
- *Isaria fumosorosea* (PFR-97 20% WDG) at 1 to 2 lb/acre of produce as soil treatment. REI 4 hr. Retreatment interval 3 to 10 days. OMRI-listed for organic use.
- thiamethoxam (Cruiser 5FS) consult label.

## Dill—Aphid

**Includes**

Bean aphid (*Aphis fabae*)  
Green peach aphid (*Myzus persicae*)  
Willow-carrot aphid (*Cavariella aegopodii*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

### **Management—chemical control: COMMERCIAL USE**

- azadirachtin (Neemix 4.5)—REI 4 hr. See label for rates. Acts slowly. Apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- afidopyropen (Versys Inscalis) at 0.01 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- gamma-cylothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. Seed crop use only.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- imidacloprid (Admire Pro) at 0.25 to 0.375 lb ai/a soil and 0.043 lb ai/a foliar. PHI soil 14 days; foliar 7 days. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season.
- imidacloprid (Provado) at 0.044 lb ai/a foliar. PHI 7 days. REI 12 hr. Do not exceed 0.13 lb ai/a per season. Retreatment interval 5 days.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.

## **Eggplant—Aphid**

### **Includes**

Bean aphid (*Aphis fabae*)  
Green peach aphid (*Myzus persicae*)  
Potato aphid (*Macrosiphum euphorbiae*)

### **Pest description and crop damage**

*See:*

Common Pests of Vegetable Crops

### **Biology and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check plants frequently after transplant or seedling emergence. Aphids often are concentrated in “hot spots.” Be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor plants particularly closely during April and May.

### **Management—biological control**

Many parasites and predators attack aphids. Monitor the proportion of aphid mummies to unparasitized adults and the number of predators such as lady beetles. If the biocontrol agents appear to be gaining control, avoid sprays which would disrupt this system. Most products available for aphid control are highly disruptive of natural enemy populations.

### **Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### **Management—chemical control: HOME USE**

- acetamiprid

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.3 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly. Apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.168 lb ai/a per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, 21 days for soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a per season for soil.
- flonicamid (Beleaf 50SG) at 0.089 to 0.133 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 2 treatments at high rate and 3 treatments at low rate. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a foliar; 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar; 45 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil, 0.0156 lb ai/10,000 plant in greenhouse and 0.047 to 0.079 lb ai/a foliar. PHI 0 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.24 lb ai/a foliar or 0.38 lb ai/a soil per season. Limit 1 greenhouse application. Foliar re-treatment interval 5 days.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.56 lb ai/a. PHI 3 days. REI 12 hr. Limit 4 applications. Retreatment interval 5 days.
- methomyl (Lannate LV) at 0.225 to 0.9 lb ai/a. PHI 5 days. REI 48 hr. Do not exceed 4.5 lb ai/a per season. Limit 10 treatments per crop.
- naled (Dibrom 8E) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatment per season. Do not exceed 5.64 lb ai/a per season.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a foliar. PHI 1 day. REI 48 hr. Do not exceed 6 lb ai/a per season. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop sea-

son.

- sulfoxaflor (Closer SC) at 0.066 to 0.07 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per year
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil treatment. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Eggplant—Colorado potato beetle

*Leptinotarsa decemlineata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Potato beetle populations initially are aggregated but tend to disperse over time. Plants can withstand considerable defoliation without yield loss (up to 30% of their foliage). Generally, insecticides do not need to be applied unless there is more than an average of one beetle or larva per plant.

### Management—biological control

Beneficial insects, such as predatory stink bugs and parasitic flies, and birds help to reduce Colorado potato beetle numbers somewhat, but they cannot be counted on to provide adequate control.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC, Epi-Mek) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season.
- acetamiprid (Assail 30SG) at 0.028 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Limit four applications per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Trident) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Slow acting. May need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Retreatment interval 7 days.
- bifenthrin /avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.

- carbaryl (Sevin SL and XLR Plus) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 7 treatments per year. Do not exceed 8 lb ai/a per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a via drip irrigation or as foliar. PHI 1 day. REI 4 hr. Retreatment interval 5 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Flexi) at 0.059 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Minimum of 5 days between applications. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year. Retreatment interval 5 days.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.168 lb ai/a per season on fruiting vegetables.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, or 21 days for soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.35 lb ai/a per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a. PHI 1 day foliar. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Do not exceed 0.18 lb ai/a per season. Retreatment interval 5 days.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil and 0.047 to 0.079 lb ai/a foliar. PHI 0 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.24 lb ai/a foliar or 0.38 lb ai/a soil per season. Foliar retreatment interval 5 days.
- imidacloprid (Provado, Prey) at 0.048 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Do not exceed 0.36 lb ai/a per season. Retreatment interval 5 days.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.233 lb ai/a per season. Retreatment interval 7 days.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a foliar. PHI 1 day. REI 48 hr. Do not exceed 6 lb ai/a per season. Retreatment interval 7 days.
- permethrin (Loveland Permethrin) at 0.15 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per year.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed three applications in any 21-day period. Do not exceed 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. Apply high rates for heavy infestations. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil treatment. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.257 lb ai/a of Durivo or 0.172 lb ai of thiamethoxam-containing products or 0.2 lb ai of chlorantraniliprole-containing products per acre per growing season.
- tolfenpyrad (Torac) at 0.14 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per season.

**Pesticide resistance management** The Colorado potato beetle is notorious for its ability to develop resistance rapidly to insecticides that are used repeatedly for control. To delay or prevent resistance, it is important to rotate the insecticides used. Commercial strains of *Bacillus thuringiensis tenebrionis* (*Btt*) are effective and can be used as part of a rotation. Manage Colorado potato beetle resistance field by field. While they may be resistant to one insecticide in a particular location, beetles in other areas within the same county may not have developed resistance to that insecticide.

## Eggplant—Flea beetle

**Includes** western potato flea beetle (*Epitrix subcrinita*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Keep areas free of weeds, particularly those of the mustard family, to which the beetles are attracted.

### Management—chemical control: HOME USE

- acetamiprid

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- imidacloprid
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply less than 7 days apart.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 7 treatments per year. Do not exceed 8 lb ai/a per year.
- chlorantraniliprole (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed of 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 64 lb ai/a per year. Some formulations are OMRI-listed for organic use.
- cyantraniliprole (Verimark) at 0.088 to 0.176 lb ai/a at planting. PHI 1 day. REI 4 hr. Do not exceed 0.176 lb ai/a at planting. Do not exceed 0.4 lb ai/a per season.
- cyfluthrin (Tombstone) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.168 lb ai/a per season on fruiting vegetables.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, or 21 days for soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.35 lb ai/a per season. Retreatment interval 7-10 days.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Do not exceed 0.18 lb ai/a per season. Retreatment interval 5 days.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Do not exceed 0.36 lb ai/a per season. Retreatment interval 5 days.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- naled (Dibrom 8E) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatment per season. Do not exceed 5.64 lb ai/a per year.
- permethrin (Loveland Permethrin) at 0.1 to 0.15 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per year.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil treatment. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.

- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per season.

## Eggplant—Four-spotted Spider mite

*Tetranychus* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (such as clove and garlic) have some efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- sulfur—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC, Epi-Mek) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season.
- acequinocyl (Kanemite 15SC) at 0.3 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per season.
- bifenazate (Acramite 50W) at 0.0375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr.
- bifenthrin (Brigade WSB) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Do not apply less than 7 days apart.
- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- borate complex (Prev-Am Ultra) applied as a 0.4% solution. Apply to complete coverage. PHI 12 hr. Retreatment interval 4 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- etoxazole (Zeal) at 0.09 to 0.135 lb ai/a. PHI 7 days. REI 12 day. Do not exceed 0.135 lb ai/a per season. Limit 1 treatment.
- fenbutatin-oxide (Vendex 50WP) at 1 to 1.5 lb ai/a. PHI 3 days. REI 48 hr. Do not exceed three applications or 4.5 lb ai/a per year. Limit 3 treatments per season.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Do not exceed 0.8 lb ai/a per season. Retreatment interval 7 days.
- fenpyroximate (Miteus) at 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments. Do not exceed 0.21 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Do not exceed 0.18 lb ai/a per season. Retreatment interval 5 days.
- hexythiazox (Onager) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 12 hr. Limit one treatment. Do not exceed 0.188 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1.56 lb ai/a. PHI 3 days. REI 12 hr. Limit 4 applications. Retreatment interval 5 days.
- naled (Dibrom 8E) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatment per season. Do not exceed 5.64 lb ai/a per year.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 6 lb ai/a per year.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a. PHI 7 days. Limit 3 treatments per year. REI 12 hr. Do not exceed 0.4 lb ai/a per season. Retreatment interval 7 days.

## Eggplant—Whitefly

Greenhouse whitefly (*Trialeurodes vaporariorum*)

Silverleaf whitefly (*Bemesia argentifolii*)

Sweetpotato whitefly (*Bemesia tabaci*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

## Management—cultural control

Inspect new plants before purchase: infestations often are introduced. Encourage natural enemies such as ladybird beetles, spiders, and parasitic wasps. Avoid use of broad-spectrum insecticides which reduce populations of these.

## Management—chemical control: HOME USE

Spray at 7-day intervals, several times if necessary. For best results, direct spray toward undersides of leaves. Read label application instructions carefully.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Limit four applications per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per year. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole /thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Minimum of 5 days between applications. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Verimark) at 0.088 to 0.176 lb ai/a at planting, drip chemigation or soil injection. PHI 1 day. REI 4 hr. Do not exceed 0.176 lb ai/a at planting or 2 drip chemigation or soil injections. Do not exceed 0.4 lb ai/a per season.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year. Retreatment interval 5 days.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, or 21 days for soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- flonicamid (Beleaf 50SG) at 0.089 to 0.133 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days. Suppresses greenhouse whiteflies.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a foliar; 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar; 45 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil, 0.0156 lb ai/10,000 plant in greenhouse and 0.047 to 0.079 lb ai/a foliar. PHI 0 days foliar; 21 days soil. REI 12 hr. Do not exceed 0.24 lb ai/a foliar or 0.38 lb ai/a soil per season. Limit 1 application greenhouse. Foliar retreatment interval 5 days.
- imidacloprid (Provado, Prey) at 0.048 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.233 lb ai/a per season. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- pyriproxyfen (Knack) at 0.054 to 0.067 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.109 lb ai/a per season. Retreatment interval 14 days. 30 day plant back restriction.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.066 to 0.07 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.047 to 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.

- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil treatment. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/a per season. Retreatment interval 7 days. Limit 3 treatments per season.

## Eggplant—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin).
- cyfluthrin
- zeta-cypermethrin (as a mix with bifenthrin)

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a in furrow with seed. PHI 0 days. REI 12 hr. Do not exceed 0.1 lb ai/a at plant or 0.2 lb ai/a at plant and foliar per season.
- bifenthrin/avermectin (Athena) at 0.083 to 0.12 lb ai/a at plant. REI 12 hr. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.

## Endive (Escarole)—Aphid

**Includes** green peach aphid (*Myzus persicae*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. REI 12 hr. PHI 7 days. Do not exceed 0.375 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- afidopyropen (Versys Inscalis) at 0.01 lb ai/a. PHI 0 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a be-

ta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.

- borate complex (Prev-Am Ultra) applied as a 0.8% solution. Apply to complete coverage. REI 12 hr. Retreatment interval 7-10 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- dimethoate (Dimethoate 400) at 0.25 lb ai/a. PHI 14 days. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- dinotefuran (Scorpion 35SG) at 0.05 to 0.13 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 7 days foliar; 21 soil applied. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.23 lb ai/a foliar per season. Foliar retreatment interval 5 days.
- imidacloprid (Provado, Prey) at 0.048 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20% WDG)—Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 3 days. Do not graze or feed. Do not exceed 0.2 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season. A penetrating adjuvant improves performance.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a, soil application. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Endive (Escarole)—Beet armyworm

*Spodoptera exigua*

**Pest description and crop damage** Beet armyworm moths have a wingspan no larger than 1.25 inches and are mottled gray and brown, with irregular banding and a light-color, bean-shaped spot. Eggs are pale green to pink, ridged, and deposited in a mass which is covered with a white cottony material. The tiny, newly hatched larvae feed in colonies. The larvae are about 1.25 inches long when full grown and are mottled olive green to almost black. Armyworm larvae feed in colonies shortly after hatching and skeletonize leaves. As they grow larger, they tend to disperse and consume irregular patches of foliage or entire leaves.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Armyworms only. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season. First and second armyworm instars.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a a) at planting; b) via drip irrigation; c) as foliar. PHI 1 day. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- indoxacarb (Avaunt) at 0.065 to 0.11 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.44 lb ai/a per crop. Retreatment interval 3 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai. PHI 10 days. REI 48 hr. Do not exceed 4.5 lb ai/a per season. Limit 8 treatments per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early season or at 0.12 to 0.16 ai/a for mid to late season. REI 4 hr. PHI 1 day. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Do not graze or feed. Retreatment interval 3 days. Do not exceed 0.2 lb ai/a per season.
- spinosad (Success, Entrust SC) at 0.06 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- *Spodoptera exigua* (Fawligen, Spexig) at 1 to 2.4 fl oz product per acre. PHI 0 days. REI 4 hr. Beet armyworm and fall armyworm only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early year; 0.12 lb ai/a mid to late year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season. Retreatment interval 7 days. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a, soil application. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Endive (Escarole)—Looper

**Includes** alfalfa looper (*Autographa californica*)

**Pest description and crop damage** Alfalfa looper adults are brownish moths with distinctive silvery figures on the front wings. Eggs are ridged and dome-shaped and usually laid singly on the undersurface of leaves. Looper caterpillars can be distinguished from most other common caterpillars by their distinctive looping movement, in which they arch the middle portion of their body to bring the hind legs forward to meet the front legs. Loopers are smooth-skinned with only a few long bristles down the back. They are green, usually with a narrow white stripe along each side and several narrow lines down the back. They may grow up to 1.5 inches long. Mature larvae spin silken cocoons and pupate, usually attached to leaves. Alfalfa loopers tend to have more dark markings than cabbage loopers. They tend to do less physical damage to plants but are a serious source of contamination.

**Biology and life history** The alfalfa looper overwinters as a pupa either in the soil or in trash near the base of host plants. Moths begin emerging in late April and May, and adults lay eggs singly on weed hosts, usually wild crucifers, rarely on crops. Eggs hatch in 3 to 5 days, and larvae feed for about 2 weeks before pupating on the host plant or in trash. The total development time is about 30 days. Adults emerge in about 7 days, mate, and females deposit eggs as before about 3 days after emerging. There are three or four generations each year.

**Pest monitoring** A sweep net can be used to sample for large larvae. Take a minimum of 100 sweeps divided into groups of 10 in different parts of the field and along the margins. Sequential sampling that involves fewer samples, and presence-absence sampling that does not involve counting, also may be used.

Pheromone traps can be used to monitor for the emergence of adult male moths. Alfalfa loopers tend to be caught in traps more often than cabbage loopers, sometimes leading to misreadings of which looper is the primary pest. More than five cabbage looper moths per trap per day constitutes significant egg-laying pressure. More than two to five large looper worms per 100 leaves 2 to 3 weeks prior to harvest may justify an early spray program.

## Management—biological control

Cabbage loopers have many natural enemies that may keep them below economic levels if they are not killed by insecticide treatments for other pests. These include several important, naturally occurring parasites. A nuclear polyhedrosis virus disease is also important under certain circumstances. Be sure to monitor for natural enemies. If looper populations are close to treatment thresholds, but you find a significant percentage of parasitized or disease-killed individuals, delay treatment for a few days to see if these natural controls will bring populations down on their own. If treatment is necessary, *Bacillus thuringiensis* insecticide minimizes injury to natural enemies.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a a) at planting; b) via drip irrigation; c) as foliar. PHI 1 day. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.065 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze livestock.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.44 lb ai/a per crop. Retreatment interval 3 days.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early season or 0.12 to 0.16 ai/a for mid to late season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Do not graze or feed. Retreatment interval 3 days. Do not exceed 2 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.05 to 0.09 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed three applications in any 21-day period. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early year; 0.12 lb ai/a mid to late year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season. Retreatment interval 7 days. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil application. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Endive (Escarole)—Wireworm

*Limoni* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant.
- diazinon (Diazinon 50W) at 3 to 4 lb ai/a. Broadcast before planting and incorporate into top 4 to 8 inches. REI 4 days.
- *Isaria fumosorosea* (PFR-97 20% WDG) applied as soil drench, chemigation or soil injection. Refer to label. OMRI-listed for organic use.

## Garlic—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Black cutworm (*Agotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use
- deltamethrin
- gamma-cyhalothrin
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary) —These have some efficacy against lepidopteran pests. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use. Oregon only.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- azadirachtin (Azatin, Neemix) at up to 0.04 lb ai/a. PHI 0 days. REI 4 hr. Use higher rates for severe infestations. May need repeat applications at intervals of 7 days or less. Monitor pest populations and avoid rescue situations. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin, Xentari) 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a foliar, at planting or as drip chemigation. PHI 1 day. REI 4 hr. Foliar retreatment interval 7 days and limit of 4 treatments. Do not exceed 0.6 lb ai/a per season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai lb/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.112 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 14 days. REI 24 hr. Do not exceed 0.12 lb ai/a per season. Use of a COC or nonionic surfactant improves performance.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season. Addition of a 1% COC or one-quarter percent of a silicone surfactant improves performance.
- methomyl (Lannate SP) at 0.45 lb ai/a. PHI 7 days. REI 48 hr. Limit 6 treatments per year. Do not exceed 2.7 lb ai/a per season. A surfactant increases efficacy.
- permethrin (Loveland Permethrin) at 0.1 to 0.3 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.8 lb ai/a per season.
- permethrin (Loveland Permethrin Bait) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.8 lb ai/a per season.
- spinosad (Success, Entrust SC) at 0.05 to 0.1 lb/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb ai/a per crop or make more than 5 application per year. Entrust SC is OMRI-listed for organic use.
- Spodoptera exigua (Spexit) at 1 to 2.4 fl oz product per acre. PHI 0 days. REI 4 hr. Beet armyworm and fall armyworm only
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per season.

## Garlic—Bulb mite

### Includes

*Rhizoglyphus* spp.

*Tyrophogus* spp.

**Pest description and crop damage** Shiny, cream-color mites. Damage results from mites penetrating the outer layer of bulb tissue, which allows entry of disease organisms. Bulb mites can reduce garlic stands, stunt plant growth, and promote rot in stored garlic bulbs.

### Management—cultural control

Plant only mite-free garlic cloves. Crop rotation and hot water treatment of seed pieces also are useful.

### Management—chemical control: HOME USE

None registered.

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant.

**Note:** Soil fumigation rarely is used prior to garlic due to the expense. Some growers plant garlic following a crop such as potatoes or carrots for which the soil was fumigated.

## Garlic—Garden symphylan

*Scutigera immaculata*

### Pest description and crop damage

*See:*

Common Pests of Vegetable Crops

### Biology and life history

*See:*

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. In general, preplant field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. Little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied.

**Management—chemical control: HOME USE**

- pyrethrins—Some formulations are OMRI-listed for organic use.

**Management—chemical control: COMMERCIAL USE**

## Garlic—Thrips

**Includes**

Onion thrips (*Thrips tabaci*)

Western flower thrips (*Frankliniella occidentalis*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

Adults overwinter in trash, under bark, and in other protected places. Adults become active in the spring and lay eggs in the tissues of plants with one end of the egg protruding slightly. The eggs hatch into nymphs, which begin feeding in flowers, buds, and leaves. When mature, nymphs drop to the ground and molt into adults. Under favorable conditions, a life cycle may require only 2 weeks.

**Pest monitoring** Thrips tend to have clumped distribution both through the field and on individual plants. Thrips are active and are dispersed readily by wind. White or yellow sticky traps are useful to monitor for thrips flights. On onions, an action threshold of one to two per leaf or 30 per plant is suggested. Treatment usually is not necessary on seedlings, because most plants recover from thrips injury.

**Management—cultural control**

Sanitation is very important. Volunteers should be rogued out. Cloves used for planting should be free of contamination. Thrips populations tend to build up on weeds. Cultivating nearby weedy areas early in the year reduces the potential for a thrips problem when the weeds begin to dry out. Cultivating weedy areas after plant emergence may increase thrips problems.

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- deltamethrin
- gamma-cyhalothrin
- insecticidal soap—may require several applications—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad —Some formulations are OMRI-listed for organic use
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Limit 2 sequential treatments. Do not exceed 0.056 lb ai/a per season.
- acetamiprid (Assail 30SG) at 0.094 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 0.6 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply as 0.8% solution. Spray for complete coverage. REI 12 hr. Retreatment interval 7-10 days. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. Suppression only. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 1.5 to 3 quarts formulated product per acre. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year. Suppression only.
- cypermethrin (Holster) at 0.08 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Adjuvants such as MSO or COC increase efficacy.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.112 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.135 to 0.18 lb ai/a foliar; 0.225 to 0.27 lb ai/a soil. PHI 1 day. REI 12 hr. Do not exceed 0.383 lb ai/a per

crop season.

- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 14 days. REI 24 hr. Do not exceed 0.12 lb ai/a per season. Use of a COC or nonionic surfactant improves performance.
- imidacloprid (Admire Pro) at 0.5 lb ai/a soil. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season. A silicone surfactant increases efficacy.
- malathion (Malathion 8) at 1.0 to 1.56 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 1.56 lb ai/a year.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a. PHI 14 days. REI 48 hr. Retreatment interval 7 days. Do not exceed 4.5 lb ai/a. WA only. SLN WA-000018.
- permethrin (Loveland Permethrin) at 0.15 to 0.3 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.8 lb ai/a per season. Retreatment interval 10 days.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 0.234 lb ai/a per season. Limit 5 treatments per season.
- spirotetramat (Movento) at 0.08 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.16 lb ai/a per season. Retreatment interval 7 days.
- spinosad (Success, Entrust SC) at 0.06 to 0.12 lb/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb ai/a per crop or make more than 5 application per year. Thrips suppression. Entrust SC is OMRI-listed for organic use.
- tolfenpyrad (Torac) at 0.24 lb ai/a. PHI 7 day. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 0.73 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.0375 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per season.

## Garlic—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—cultural control

Crop rotation is an important practice for controlling wireworms in garlic. Soil fumigation rarely is used in garlic due to the high cost.

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- pyrethrins (as a mix with azadirachtin)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant.
- diazinon (Diazinon 50W) at 3 to 4 lb ai/a. Broadcast before planting and incorporate into the top 4 to 8 inches of soil. REI 3 days.

## Horseradish—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (sometimes as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin

- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply as 0.8% solution. Spray for complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. Suppression only. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.14 lb ai/a per season. Retreatment interval 3 days.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.156 to 0.38 lb ai/a soil and 0.044 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Limit 3 treatments per year. Retreatment interval 7 days.
- methomyl (Lannate SP) at 0.45 lb ai/a. PHI 65 days. REI 48 hr. Ground application only. Limit 4 treatment per year. Do not exceed 1.8 lb ai/a per season.
- sulfoxaflor (Transform WG) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 24. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a. REI 12 hr. Do not exceed 0.188 lb ai/a per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.

## Horseradish—Cabbage flea beetle

*Phyllotreta cruciferae*

**Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours. Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 feet of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

**Management—cultural control**

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.14 lb ai/a per season. Retreatment interval 3 days.
- imidacloprid (Admire Pro) at 0.156 to 0.38 lb ai/a soil and 0.044 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season.
- imidacloprid (Provado) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Limit 3 treatments per year. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.047 to 0.063 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 4 days. Limit 4 applications per year. Do not exceed 0.219 lb ai/a per season. Follow resistance management procedures on the label. Suppression only.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.33 lb ai/a per season. Retreatment interval 5 days. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a. REI 12 hr. Do not exceed 0.188 lb ai/a per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.
- zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

## Horseradish—Cutworm

**Includes**

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

**Management—chemical control: HOME USE**

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench (when bees are not present) may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- permethrin
- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- carbaryl (Sevin 4F, Sevin 5 Bait) at 1 to 2 lb ai/a foliar and 2 lb bait/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per season. Limit 3 treatments per season.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.14 lb ai/a per season. Retreatment interval 3 days.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 14 days. Do not exceed 1 lb ai/a per season.

- zeta-cypermethrin (Mustang) at 0.016 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

## Horseradish—Diamondback moth

*Plutella xylostella*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, take into account the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- cyfluthrin
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- azadirachtin (Neemix 4.5) 10 to 16 fl oz/100 gal. consult label for rates. REI 4 hr. PHI 0 day.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- GS-omega/kappa-Htxx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Limit 3 treatments per year. Retreatment interval 7 days.
- permethrin (Loveland Permethrin) at 0.15 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed three applications. Washington and Oregon only.

## Horseradish—Imported cabbageworm

*Pieris rapae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** The following information is from California but is generally applicable in the Pacific Northwest: Cabbageworms can be monitored at the same time as cabbage loopers. Sample 25 plants selected randomly throughout the field. Although treatment levels combine the two species, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant, often near the midribs of leaves. Good clues to cabbageworm presence include their greenish brown fecal pellets or many white cabbage butterflies fluttering around the field (check for eggs in a few days).

Base treatment on numbers of healthy larvae present. Treat seedlings or small plants if populations of medium-size to large caterpillars are high enough to stunt growth.

### Management—biological control

Natural enemies can assist significantly in the control of imported cabbageworm. Important parasites include the pupal, larval, and egg parasites in the *Trichogramma* genus, as well as tachinid flies. Timely mass releases of commercially available trichogramma during peak flight can be an effective control agent. Viruses and bacterial diseases are also sometimes important control factors in the field. If possible, use *Bacillus thuringiensis* to avoid adverse impact on natural enemies. *Bt* is very effective against imported cabbageworm, especially when applied to young (early-instar) caterpillars.

### Management—cultural control

Make new plantings as far as possible from those of the previous year. At the end of the year, harvest crops without delay. Plowing under or destroying plant residues at this time eliminates an important food source for the overwintering generation of cabbageworms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- kaolin—Applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- GS-omega/kappa-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

## Horseradish—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

## Kale—see Collard and kale

## Kohlrabi—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

**Pest description and crop damage** The cabbage aphid is gray-green with a waxy bloom. It forms dense colonies that cannot be removed before processing or marketing. The turnip aphid looks very much like the cabbage aphid but lacks the waxy bloom. It tends to be more evenly distributed over plants. Aphids damage plants by contaminating harvest; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; sucking plant sap, which causes heavily infested leaves to curl and stunts plants; and spreading plant diseases (a large number of viruses are spread by aphids). Infestations frequently are localized, with heavily infested leaves curled downward.

### Biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

## Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not entering a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

## Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

## Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed five applications or 0.375 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 applications. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a (suppression only). PHI 3 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorpyrifos (Lorsban 75WG) at 0.5 to 1.0 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 3 applications per season. **RESTRICTED USE IN OREGON.**
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluth-

rin or 0.24 lb ai/a imidacloprid per year.

- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a as foliar spray, at 0.23 to 0.27 lb ai/a as soil treatment. PHI 7 day foliar; 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a (foliar) or 0.532 lb ai/a (soil application) per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.38 lb ai/a soil and 0.23 lb ai/a foliar per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 2 treatment per year.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Armyworm and looper

### Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Alfalfa looper (*Autographa californica*)  
Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary and thyme oil)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix) at up to 0.04 lb ai/a. PHI 0 days. REI 4 hr. Neemix is OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.

- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.5 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil applied in furrow with seed or transplant. REI 12 hr. Armyworm only. Do not exceed 0.5 lb ai/a per season including at-plant plus foliar treatments.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F, Sevin 5 Bait) at 1 to 2 lb ai/a foliar or 2 lb ai/a bait. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 foliar or 3 soil treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a a) at planting; b) via drip irrigation; c) as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.049 to 0.088 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorpyrifos (Lorsban 75WG) at 0.5 to 1.0 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 3 applications per season. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- cypermethrin (Holster) at 0.075 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.4 lb ai/a per year. Cabbage looper only.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves performance.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 2 treatment per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early-season application and 0.12 to 0.16 lb ai/a for mid to late-season application or heavy infestation. PHI 1 day. REI 4 hr. Adding adjuvant improves performance. Do not exceed 1.0 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.05 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Retreatment interval 4 days. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early season, or 0.12 lb ai/a mid to late season. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai per application or 0.625 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a thiamethoxam or 0.2 lb ai/a chlorantraniliprole per season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Cabbage maggot

*Delia radicum*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate. If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments would be of little value. Sticky traps and sweep nets also can be used to monitor the adult fly.

#### **Management—biological control**

Rove beetles prey on maggot eggs and young larvae. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp *Trybliographa rapae* lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

#### **Management—cultural control**

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seedrow. It is believed that adult flies can locate the seed row for egg-laying by homing in on the higher moisture levels created when the soil is overturned for planting.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops unless sufficient time has passed for the residue to dry or to decompose completely.

#### **Management—chemical control: HOME USE**

- pyrethrins (often as a mix with azadirachtin)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

Every year, in areas where cabbage maggot causes economic injury, treat spring planted or transplanted crops with a band of insecticide at the base of the plant at the time of planting or transplanting. Later sprays cannot be relied upon to control the pest effectively. Treat seedbeds for transplanted crops with an insecticide.

- bifenthrin (Brigade WSB, Capture LFR) at 0.04 to 0.1 lb ai/a as in-furrow treatment. REI 12 hr. Do not exceed 0.1 lb as at-plant treatment. Some formulations are labeled for OMRI use.

## **Kohlrabi—Cucumber beetle**

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- imidacloprid
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Capture LFR, Brigade WSB) at 0.04 to 0.1 lb ai/a soil applied. PHI 7 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications after bloom.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.

- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 days foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Biology and life history** During mild winters, the black cutworm overwinters in field debris and brush as a pupa. Otherwise, it flies in from warmer climates in late spring.

The variegated cutworm overwinters in the soil or under trash as a partially mature larvae. The larvae begin feeding in early spring and may do damage to seedlings. Larvae mature in late April and May and pupate in earthen cells in the soil. Adults emerge in late May and June.

Eggs hatch in 4 to 7 days, and larvae begin to feed on plant foliage. Larvae feed for 4 to 6 weeks, then pupate in the soil. Adults emerge in late August and lay eggs which hatch into larvae. These form the overwintering stage for the variegated cutworm. There are two generations each year.

**Pest monitoring** Pheromone traps can be used to monitor for cutworms in conjunction with field scouting. Moth counts in excess of two black cutworm moths per trap per day indicate significant egg laying pressure. When moth counts exceed this level, intensify field scouting at crop emergence and during stand establishment.

If the cutworm population is reducing the plant stand, treat during the seedling stage. Frequently, the damage is most serious at the edges of a field, but stand loss can occur in a spotty pattern throughout the field.

Usually, it is necessary to dig in the soil to find black cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved. Larvae normally hide under debris on the soil surface during the day, but are active, voracious feeders at night.

Since extensive damage may occur in a short period of time, inspect plant beds and newly set plants frequently. In North Carolina, an economic threshold of 5% injured plants has been established for cutworms infesting newly set or young plants (within 3 weeks after transplanting). In Ontario, Canada, the guideline for black cutworm on many seedling vegetables is also 5% plants infested.

### Management—biological control

Cutworms are attacked by a number of predators, parasites, and diseases. Many of these natural control agents are not effective on pale western and black cutworms because of their subterranean nature. It is not known if any of these natural enemies can control cutworm populations, but their presence should be noted.

### Management—cultural control

Cutworms are most injurious in fields with high plant residue. Historically, cutworms are a problem in early, spring-seeded seedling fields. Tillage prior to seeding is an effective means of reducing cutworm damage. A thorough harrowing between rows may reduce the number of cutworms feeding actively in established fields.

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.

- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at up to 0.04 lb ai/a. PHI 0 days. REI 4 hr. Neemix is OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.5 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil applied in furrow with seed or transplant. REI 12 hr. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 applications. Do not exceed 0.45 lb ai/a per season.
- carbaryl (Sevin 5 Bait) at 2 lb ai/a as granule. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.049 to 0.078 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorpyrifos (Lorsban 75WG) at 0.5 to 1 lb ai/a foliar; 2.25 lb ai/a soil. PHI 21 days foliar; 30 days soil. REI 24 hr. Do not exceed 3 applications per season. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves performance.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Diamondback moth

*Plutella xylostella*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

In Minnesota, action thresholds for diamondback moth in cabbage are: Where diamondback moth is the primary insect pest (usually early-year), before cupping, treat with *Bacillus thuringiensis* if 50% of plants are infested with five or more larvae each. After cupping, treat if 10% of plants are infested with one or more larvae each.

### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, take into account the level of parasitism when making control decisions.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl

- cyfluthrin
- gamma-cyhalothrin
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: **COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at up to 0.04 lb ai/a. PHI 0 days. REI 4 hr. Neemix is OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a (larvae only). PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 6 lb ai/a per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a a) at planting; b) via drip irrigation; c) as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorpyrifos (Lorsban 75WG) at 0.5 to 1 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 3 applications per season. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves performance.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- novaluron (Rimon 0.83EC) at 0.039 to 0.078 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per season.
- spinetoram (Radiant SC) at 0.0391 to 0.0781 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.023 to 0.063 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed three applications in a 30-day period. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a thiamethoxam or 0.2 lb ai/a chlorantraniliprole per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Flea beetle

**Includes** cabbage flea beetle (*Phyllotreta cruciferae*)

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours.

Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 ft of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

#### **Management—cultural control**

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high value crops. Flea beetles can be vacuumed off foliage, but this practice must be repeated frequently. Reinvasion of plants can be rapid.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- imidacloprid
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (such as rosemary)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.5 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil applied in furrow with seed or transplant. REI 12 hr. Do not exceed 0.5 lb ai/a per season including at-plant plus foliar treatments. Larvae only. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.45 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 6 lb ai/a per year.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb/a per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves performance.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Retreatment interval

5 days. Do not exceed 0.38 lb ai/a soil and 0.23 lb ai/a foliar per season.

- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 2 treatment per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Imported cabbageworm

*Pieris rapae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** The following information is from California but is generally applicable in the Pacific Northwest. Cabbageworms can be monitored at the same time as cabbage loopers. Sample 25 plants selected randomly throughout the field. Although treatment levels combine the two species, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant, often near the midribs of leaves. Good clues to cabbageworm presence include their greenish brown fecal pellets, or many white cabbage butterflies fluttering around the field (check for eggs in a few days).

Base treatment on numbers of healthy larvae present. Treat seedlings or small plants if populations of medium-size to large caterpillars are high enough to stunt growth.

### Management—biological control

Natural enemies can assist significantly in the control of imported cabbageworm. Important parasites include the pupal, larval, and egg parasites in the *Trichogramma* genus, as well as tachinid flies. Timely mass releases of commercially available trichogramma during peak flight can be an effective control agent. Viruses and bacterial diseases are also sometimes important control factors in the field.

### Management—cultural control

Make new plantings as far as possible from those of the previous year. At the end of the year, harvest crops without delay. Plowing under or destroying plant residues at this time eliminates an important food source for the overwintering generation of cabbageworms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days. Maximum 5 applications.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 6 lb ai/a per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a a) at planting; b) via drip irrigation; c) as foliar. PHI 3 days. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorpyrifos (Lorsban 75WG) at 0.67 to 1 lb ai/a. PHI 21 days. REI 24 hr. Limit 3 treatments. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves performance.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- lambda-cyhalothrin /thiamethoxam (Endigo ZC) at 0.064 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.24 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 2 treatment per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early-season application and 0.12 to 0.16 lb ai for mid- to late-season application or heavy infestation. PHI 1 day. REI 4 hr. Adding adjuvant improves performance. Do not exceed 1.0 lb ai/a per season.
- novaluron (Rimon 0.83 EC) at 0.039 to 0.078 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house, or field plot. Limit 6 treatments per season
- spinosad (Success, Entrust SC) at 0.047 to 0.063 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a or six applications per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early season, or 0.12 lb ai/a mid to late season. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Kohlrabi—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Brigade WSB, Capture LFR) at 0.04 to 0.08 lb ai/a soil applied in furrow with seed or transplant. REI 12 hr. Do not exceed 0.5 lb ai/a per season including at-plant plus foliar treatments. Some formulations are
- chlorpyrifos (Lorsban Advanced 2ee) at 2.11 lb ai/a. PHI 30 days. REI 24 hr. Incorporate into top 2 to 4 inches of soil. Oregon and Washington only. **RESTRICTED USE IN OREGON.**
- chlorpyrifos (Lorsban 75WG) at 0.05 to 0.09 lb ai/1,000 row ft post plant or 2.25 lb ai/a preplant. PHI 30 days. REI 24 hr. Apply at planting or transplanting. Apply only once per season. **RESTRICTED USE IN OREGON.**

## Leek and shallot—Thrips

**Includes** onion thrips (*Thrips tabaci*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Thrips tend to have clumped distribution both through the field and on individual plants. Thrips are active and are dispersed readily by wind. White or yellow sticky traps are useful to monitor for thrips flights. On onions, an action threshold of one to two per leaf or 30 per plant is suggested. Treatment is usually not necessary on seedlings, because most plants recover from thrips injury. The marketability of leeks is reduced by thrips scarring. Apply treatments at the first sign of thrips feeding.

Thrips also are beneficial at this time because of their role as mite predators.

### **Management—cultural control**

Sanitation is very important. Volunteers should be rogued out. Cloves used for planting should be free of contamination. Thrips populations tend to build up on weeds. Cultivating nearby weedy areas early in the year reduces the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after plant emergence may increase thrips problems. Overhead irrigation and rainfall provide some suppression of thrips populations, but treatments are often still necessary.

### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- acetamiprid
- capsaicin—Some formulations are OMRI-listed for organic use. Not registered on shallots.
- deltamethrin
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant-derived essential oils (such as rosemary and thyme oil)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

Thorough coverage is essential for control, as most thrips feed in protected areas of the plant.

- acetamiprid (Assail 30SG) at 0.094 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatment per year. Do not exceed 0.6 lb ai/a per season.
- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season. Shallots only.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use. Leeks only.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 3 to 6 pints formulated product per acre. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year. Suppression only.
- dinotefuran (Scorpion 35SL) at 0.135 to 0.18 lb ai/a foliar or 0.225 to 0.27 lb ai/a soil. PHI 1 day foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.27 lb ai/a per season.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.4 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.234 lb ai/a per season. Limit 5 treatments per season.
- spinosad (Entrust SC) at 0.06 to 0.12 lb/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb ai/a per crop or make more than 5 applications per year. Suppression. Entrust SC is OMRI-listed for organic use.
- spirotetramat (Movento) at 0.08 lb ai/a. PHI 3 days shallots, 7 days leeks. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- tolfenpyrad (Torac) at 0.24 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 0.73 lb ai/a per year.

**Pesticide resistance management** Resistance to organophosphate has been documented in several states and is suspected in California. For this reason, alternate insecticides from different chemical families when multiple treatments are needed during a year.

## Lentil—Aphid

### Includes

Bean aphid (*Aphis fabae*)  
Green peach aphid (*Myzus persicae*)  
Pea aphid (*Acyrtosiphon pisum*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- imidacloprid
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day succulent, 21 days dried. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a beta-cyfluthrin or 0.1 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.0875 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply as 0.8% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- dimethoate (Dimethoate 4E) at 0.25 to 0.5 lb ai/a. PHI 14 days. REI 48 hr. Do not feed or graze treated plants. Do not exceed 1 lb ai/a per season. Retreatment interval 7 days. Also available as SLN ID-860004, ID-900001, ID-890007, ID-940008, ID-940002.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not graze or harvest for feed.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.06 lb ai/a per season. Retreatment interval 5 days. Do not graze or harvest for feed. An oil or nonionic surfactant improves performance.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil and 0.043 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Apply in-furrow or by chemigation as soil treatment. See label directions. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.13 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. Do not graze or harvest for feed.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.

## Lentil—Lygus bug

*Lygus* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Sweep nets can be used to sample for lygus bugs. In the Pacific Northwest, a suggested treatment threshold is one-half adult or one-half fourth- or fifth-instar per sweep. In California, for dry beans, treatment thresholds vary depending on the variety and the stage of the crop, from one-half to two lygus bugs per sweep. In celery, treatment thresholds range from one-half to one insect per plant.

#### **Management—biological control**

Generalist predators, such as lacewings and damsel bugs, may prey on lygus bug nymphs. Conserve populations of these biological control agents by minimizing applications of broad-spectrum insecticides.

#### **Management—cultural control**

Lygus bugs are likely to move when other food sources become unsuitable. Common weeds that are good hosts of lygus bugs include pigweed and wild radish. Mowed alfalfa fields nearby are commonly a source of large numbers of lygus bug adults. A number of practices can reduce or control the movement of adults from alfalfa into nearby bean fields. These techniques leave uncut, tall alfalfa (which is attractive to lygus bug adults) within or near the cut area.

#### **Management—chemical control: HOME USE**

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.0875 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply at 0.4% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem Prime) at 4 to 8 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 7 days. Retreatment interval 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay.
- dimethoate (Dimethoate 4E) at 0.5 lb ai/a. PHI 14 days. REI 48 hr. Do not feed or graze treated plants. Do not exceed 1 lb ai/a per season. Retreatment interval 7 days. Also available as SLN ID-900001, ID-980008, ID-970011, ID-860016, ID-970008, ID-860004.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.06 lb ai/a per season. Retreatment interval 5 days. Do not graze or harvest for feed. An oil or nonionic surfactant improves performance.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. Do not graze or harvest for feed.

## **Lentil—Seedcorn maggot**

*Delia platura*

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Slow emergence and poor stand establishment are signs of seedcorn maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence increase susceptibility to seedcorn maggot infestation. To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply bakers yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult seedcorn maggot flies as they are attracted to carbon dioxide.

#### **Management—cultural control**

To reduce attractiveness of the field to egg-laying adults, disc or plow early in the year, incorporating residues from a previous crop and destroying weed growth. Plant under ideal soil and weather conditions to assure rapid seed germination and minimize the seedcorn maggot problem.

One of the most reliable control methods now in general use is to plant seeds that are treated with an appropriate insecticide in the seed box at planting. However, this treatment is not sufficient to provide field protection against seedcorn maggots.

#### **Management—chemical control: HOME USE**

- bifenthrin (as a mix with zeta-cypermethrin).
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- captan/carboxin/imidacloprid (Enhance AW) at 0.1875 lb ai/100 lb seed. REI 12 hr.
- chlorpyrifos (Lorsban 4E) at 0.0625 lb ai/1,000 row ft as preplant broadcast or 0.056 lb ai/1,000 row ft as at-plant T-band. REI 24 hr. **RESTRICTED USE IN OREGON.**
- thiamethoxam (Cruiser 5FS) at 0.5 oz ai/100 lb of seed. REI 12 hr.
- thiamethoxam/mefenoxam/fludioxnil (Cruiser Maxx) at 3 fl oz product per 100 lb seed. Minimum plantback interval 120 days from planting. See label instructions.

## Lentil—Western yellowstriped armyworm

*Spodoptera praefica*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Monitoring to catch infestations early is important, because *Bacillus thuringiensis* (*Bt*) insecticides work much more effectively on small larvae.

### Management—biological control

Common natural enemies of armyworms include several braconid and ichneumonid wasps and many general predators, including assassin bugs, damsel bugs, spiders, and a nuclear polyhedrosis virus, reported to have brought about excellent late year control in Canada. None of these natural enemies can be counted upon to achieve adequate control in any given year.

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. As weeds dry, large populations of armyworms can move onto crops. When infested alfalfa fields are mowed, large dispersions of armyworms also can take place. Fall tillage can help destroy overwintering pupae.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. PHI 1 day for succulent, 21 day for dried shelled lentils. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.05 lb ai/a per season. Do not feed treated vines or hay to livestock. Retreatment interval 14 days.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a beta-cyfluthrin or 0.1 lb ai/a imidacloprid per season. Effective on first and second instars.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.39 to 0.49 oz ai/1,000 ft row at planting. REI 12 hr. Do not exceed 0.1 lb ai/a per season as an at-plant application. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.0875 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.13 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- carbaryl (Sevin 4F) at 1 to 1.5 lb ai/a. PHI 14 days of grazing 21 days harvest for dry lentils. Retreatment interval 7 days. REI 12 hr. Do not exceed 6 lb ai/a per season. Limit 4 treatments.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 7 days. Retreatment interval 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.06 lb ai/a per season. Retreatment interval 5 days. Do not graze or harvest for feed. An oil or nonionic surfactant improves performance.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 21 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. Do not graze or harvest for feed.

- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 21. REI 48 hr. Do not exceed 0.9 lb ai/a per season. Limit 2 applications per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early season and 0.12 to 0.25 lb ai/a mid season and 0.16 to 0.25 lb ai/a late season. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 1 lb ai/a per season.

## Lettuce—Aphid

### Includes

Green peach aphid (*Myzus persicae*)

Lettuce aphid (*Nasonovia ribisnigri*)

Potato aphid (*Macrosiphum euphorbiae*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

- acetamiprid
- azadiractin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90WDG) at 0.5 to 1 lb ai/a. PHI 21 days. REI 24 hr. Head lettuce only. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 2 lb ai per season. Do not graze or feed treated plants.
- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. REI 12 hr. PHI 7 days. Do not exceed 0.375 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadiractin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Head lettuce only. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.048 to 0.116 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.056 lb ai/a avermectin or 0.5 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season. Head lettuce only.
- borate complex (Prev-Am Ultra) apply as 0.8% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.

- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- diazinon (Diazinon 50W) at 0.25 to 0.5 lb ai/a. PHI 14 days. REI 3 days. Limit one treatment per year.
- dimethoate (Dimethoate 4E) at 0.25 lb ai/a. PHI 14 days. REI 48 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Leaf lettuce only.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 7 days foliar and 21 day for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.38 lb ai/a soil or 0.23 lb ai/a foliar per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20% WDG)—Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8E) at 1.25 to 1.88 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval head lettuce 6 days, leaf lettuce 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 7 days at low rate; 10 days at high rate. REI 48 hr. Retreatment interval 2 days. Do not exceed 7.2 lb ai/a for head or 3.6 lb ai/a for leaf per season.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per crop.
- pyriproxyfen (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 3 days. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.024 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.257 lb ai/a per season. Limit 1 treatment per year.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Lettuce—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)  
 Bertha armyworm (*Mamestra configurata*)  
 Western yellowstriped armyworm (*Spodoptera praefica*)  
 Black cutworm (*Agotis ipsilon*)  
 Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90WDG) at 1 lb ai/a. PHI 21 days. REI 24 hr. Armyworm only. Crisp head lettuce only. Retreatment interval 7 days. Limit treatments per year. Do not exceed 2 lb ai/a per season. Do not graze or feed treated plants.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.048 to 0.116 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.056 lb ai/a avermectin or 0.5 lb ai/a bifenthrin per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Head lettuce only. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season. Head lettuce only.
- borate complex (Prev-Am Ultra) apply as 0.8% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 6 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments per year. Armyworm only.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a soil or foliar. PHI 1 day. REI 4 hr. Do not exceed 0.8 lb ai/a chlorantraniliprole per season. Retreatment intervals 3 days foliar, 10 days drip chemigation. Limit 4 treatments.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.058 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.5 lb ai/a per season.
- diazinon (Diazinon 50W) at 2 lb ai/a. Broadcast just before planting and incorporate. PHI 14 days. REI 3 days. Cutworms only.

- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.15 lb ai/a per season. Adding an oil or nonionic surfactant improves performance.
- indoxacarb (Avaunt) at 0.065 to 0.11 lb ai/a. PHI 3 days. REI 12 hr. Use of wetting agent recommended. Retreatment interval 3 days. Do not exceed 0.44 lb ai/a per season. Armyworm only.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 7 days at low rate; 10 days at high rate. REI 48 hr. Retreatment interval 2 days. Do not exceed 3.6 lb ai/a on leaf or 7.2 lb ai/a on head lettuce per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early season and 0.12 to 0.16 lb ai/a mid to late season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season. Beet armyworm only.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Armyworms only.
- spinosad (Success, Entrust SC) at 0.063 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Armyworms only. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- *Spodoptera frugiperda* (Fawcigen) at 1 to 2.4 fl oz product per acre. PHI 0 day. REI 4 hr. Beet armyworm only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-year; 0.12 lb ai/a mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary for heavy infestations.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.257 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Lettuce—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Sniper) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Head lettuce only. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.056 lb ai/a avermectin or 0.5 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin. Retreatment interval 7 days.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.5 lb ai/a per season.

- dinotefuran (Scorpion 35SL) at 0.05 to 0.013 lb ai/a foliar or 0.23 to 0.27 soil. PHI 7 days foliar; 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 soil per season. See label.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Lettuce—Lettuce root aphid

*Pemphigus bursarius*

**Pest description and crop damage** Lettuce root aphids can be distinguished from other aphids found on lettuce by their short antennae (less than one-third body length) and undeveloped “tailpipes” (cornicles). They are found on lettuce roots in clustered colonies covered with a white powdery wax. Plants heavily attacked may wilt during the day. The developing heads remain soft, fail to develop properly, and yields are reduced. Extremely heavy aphid populations over a prolonged period can cause collapse and death of the plant. Individual rootlets turn brown and die. Masses of white, woolly material and aphids are present on roots.

**Biology and life history** Where lettuce or related weeds are not available, these aphids overwinter in the egg stage on the bark of Lombardy poplar. They develop to adults and reproduce once on poplar before migrating to lettuce. On lettuce, they begin to feed and reproduce; winged adults develop that can spread from field to field. Lettuce root aphid is a serious pest mostly where lettuce is planted near Lombardy poplars.

### Management—cultural control

Remove Lombardy poplars in the vicinity of lettuce fields to reduce the severity of root aphid infestations on lettuce. Avoid stressing plants and maintain optimum water levels. To help reduce an infestation, eliminate cracks where aphids enter the soil and attack plant roots. If an infestation occurred on the previous crop, work the soil deeply and allow it to dry thoroughly before replanting to lettuce. Rototilling an infested crop does not eliminate the population before replanting.

Some varieties of lettuce are resistant to this aphid.

If infested lettuce grows rapidly, a satisfactory crop often may result.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil treatment. PHI 7 days. REI 12 hr. Head lettuce only. Do not exceed 0.1 lb ai/a at-plant and 0.5 lb ai/a per season. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.

## Lettuce—European earwig

*Forficula auricularia*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** If you are seeing damage to young shoots of vegetables or perennials, you can confirm the presence of earwigs in the garden by placing a sheet of corrugated cardboard, hollow bamboo cane, sections of old garden hose, or similar material that will provide shelter in the garden. Check the materials each morning for presence of the insects.

### Management—cultural control

Cultivation of the soil in early spring in areas where earwigs are present will disturb nests and expose eggs to predators. Do not allow debris and decaying organic matter to accumulate in the garden. Starting vegetable gardens early will give young plants a chance to grow before nymphs become active.

**Homeowners:** Earwigs can be trapped by using the monitoring techniques described above. Empty traps each morning into a pail of water topped with detergent. Earwigs are attracted strongly to fish oil and to some extent to vegetable oil. Insects can be trapped by filling shallow containers with the oil and burying it in soil up to its rim.

### Management—biological control

Tachinid flies are predators of earwigs. They are dark brown with pinchers at the rear end. They often feed in blossoms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- insecticidal soap—Some formulations OMRI-listed for organic use.

- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Lettuce—Looper

### Includes

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological control

Loopers have many natural enemies that keep damage to a minimum if they are not killed by insecticide applications. These include naturally occurring parasites and virus diseases.

### Management—cultural control

Rotate plantings, and harvest without delay at the end of the season. Remove plant debris from the field at the end of harvest.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.020 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- acephate (Acephate 90WDG) at 1 lb ai/a. PHI 21 days. REI 24 hr. Head lettuce only. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 2 lb ai per season. Do not graze or feed treated plants.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. Use a spreader-sticker to enhance control. Bt may be combined with malathion for both worm and aphid control. Check the label for registered uses of the new, improved strains of Bt (Javelin). Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Retreatment interval 7 days.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Head lettuce only. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.048 to 0.116 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.056 lb ai/a avermectin or 0.5 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a

per season. Head lettuce only.

- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a soil or foliar. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a Coragen or 0.8 lb ai/a chlorantraniliprole per season. Retreatment intervals 3 days foliar, 10 days drip chemigation. Limit 4 treatments.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyantraniliprole (Exirel) at 0.065 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- cypermethrin (Holster) at 0.075 to 0.1 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 7 days. Head lettuce only. Do not exceed 0.5 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.15 lb ai/a per season. An oil or nonionic surfactant improves performance.
- GS-omega/kappa-Hctx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Using wetting agent is recommended. Do not exceed 0.044 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a per season.
- malathion (Fyfanon 8E) at 1.88 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval head lettuce 6 days, leaf lettuce 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.25 to 0.9 lb ai/a. PHI 7 days at low rate; 10 days at high rate. REI 48 hr. Retreatment interval 2 days. Do not exceed 3.6 lb ai/a on leaf or 7.2 lb ai/a on head lettuce per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early-season and 0.12 to 0.16 lb ai/a mid- to late-season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season. Do not feed refuse to livestock.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed six applications or 0.266 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Cabbage looper only.
- spinosad (Success) at 0.05 to 0.09 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Some formulations are OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-year and 0.12 lb ai/a mid- to late-year per application. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary for heavy infestations.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.257 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Lettuce—Slug

### Includes

Arion spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde.

- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

**Management—chemical control: COMMERCIAL USE**

- iron phosphate baits at 0.24 to 0.44 lb ai/a. REI 4 hr. PHI 1 day.
- metaldehyde baits. Use as directed by label. Do not contaminate edible plant parts. REI 12 hr.

## Lettuce—Wireworm

*Limonius* spp.

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—biological, cultural, tactical**

*See:*

Potato, Irish—Wireworm

**Management—chemical control: HOME USE**

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- diazinon (Diazinon 50W) at 2 lb ai/a. Broadcast just before planting and incorporate into the top 4 to 8 inches. REI 3 days.

## Melon (Cantaloupe, muskmelon, and watermelon)—Aphid

**Includes**

Bean aphid (*Aphis fabae*)

Melon aphid (*Aphis gossypii*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. Row covers can be effective.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

**Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidicloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion—Do not apply unless leaves are dry.
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

## Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.075 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 2 to 3 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a soil, 0.15 to 0.2 lb ai/a foliar. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- diazinon (Diazinon 50W) at 0.5 to 1.5 lb ai/a foliar. PHI 3 days. REI 3 days. Honeydew melons only.
- dimethoate (Dimethoate 400) at 0.5 lb ai/a melons except watermelon; 0.25 to 0.5 lb ai/a watermelon. PHI 3 days. REI 48 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/a per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar or 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a foliar; 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar; 21 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil or 0.0156 lb ai/10,000 plants for planthouse. PHI 21 days soil. REI 12 hr. Do not exceed 0.38 lb ai/a per soil application.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- gamma-cyhalothrin (Declare) at 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- *Isaria fumosorosea* (PFR-97 20% WDG)—Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- malathion (Fyfanon 8) at 1 to 1.5 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments for watermelon and 2 treatments for all others. Retreatment interval 7 days. Note: EC formulations may cause phytotoxicity on melons.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a and 3 days at 0.9 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.14 lb ai/a per year. Apply by ground equipment.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.09 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb ai/a lambda cyhalothrin per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil application. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agrotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

## Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

## Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.088 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Retreatment interval 7 days.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a soil treatment at planting or foliar. PHI 1 day. REI 4 hr. Limit 4 treatments per year. Retreatment interval 5 days foliar, 10 days drip. Do not exceed 0.6 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.013 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a as seedling spray. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.09 lb ai/a per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a or 3 days at 0.9 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.16 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 1.2 lb ai/a per season watermelons; cantaloupes 0.8 lb ai/a per season. Cutworms only.
- spinosad (Success, Entrust SC) at 0.0625 to 0.125 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- *Spodoptera frugiperda* or *exigua* (Fawligen, Spexit) at 1 to 2.5 fl oz product per acre. PHI 0 day. REI 4 hr. Beet armyworm and fall armyworm only.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb ai/a lambda cyhalothrin per season.
- zeta-cypermethrin (Mustang) at 0.016 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description and crop damage** The western spotted cucumber beetle is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white except for the head and last abdominal segment, which are brown. They are about 0.62 inch long. Cucumber beetle adults eat small holes in the leaves and flowers of many crops. Larvae feed on roots and bore into the base of stems.

### Management—cultural control

Row covers provide good protection from cucumber beetles, and in addition provide late frost protection and help in moisture retention. Sometimes, the timing of a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Delaying planting until warmer weather also gives crops a greater chance of outgrowing beetle injury. Trap crops may be effective in drawing beetles away from the main crop.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) 0.047 to 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.088 lb ai/a per season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a soil, 0.15 to 0.2 lb ai/a foliar. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 61.4 lb ai/a per season. Some formulations are OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.038 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- diazinon (Diazinon 50W) at 0.5 to 1.5 lb ai/a foliar. PHI 3 days. REI 3 days. Honeydew melons only.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day foliar; 21 days soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.09 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per application.
- malathion (Fyfanon 8) at 1 to 1.5 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments for watermelon & 2 treatments for all others. Retreatment interval 7 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a or 3 days at 0.9 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb ai/a lambda cyhalothrin per season.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Grasshopper

Various species

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- malathion
- permethrin
- pyrethrins (often combined with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.088 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Do not make applications less than 7 days apart.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.09 lb ai/a per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb ai/a lambda cyhalothrin per season.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Looper

**Includes** cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

The major damage caused by larvae and pupae is contamination of the heads of cole crops and severe defoliation of alfalfa, peas, sugar beets, beans, mint, and spinach.

### Management—chemical control: HOME USE

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—These have some efficacy against lepidopteran larvae. Some formulations

are OMRI-listed for organic use.

- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.088 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Do not make applications less than 7 days apart.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at planting, drip or foliar. PHI 1 day. REI 4 hr. Limit 4 treatments per year. Retreatment interval 5 days foliar, 10 days drip. Do not exceed 0.6 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyantraniliprole (Exirel) at 0.065 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a season.
- indoxacarb (Avaunt) at 0.045 to 0.11 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.44 lb ai/a per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 at 0.45 lb ai/a or 3 days at 0.9 lb ai/a. REI 48 hr. Limit 12 treatments per year. Do not exceed 5.4 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.16 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 1.0 lb ai/a per season.
- novaluron (Rimon 0.8EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 1.2 lb ai/a per season watermelons; cantaloupes 0.8 lb ai/a per season.
- spinosad (Success, Entrust SC) at 0.0625 to 0.125 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb ai/a lambda cyhalothrin per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.254 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Spider mite

*Tetranychus* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

#### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- horticultural oil Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (clove, cottonseed, garlic etc.)—Some formulations are OMRI-listed for organic use.
- sulfur (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

#### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC, Epi-Mek) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Do not make more than two sequential applications or exceed 0.056 lb ai/a per season.

- bifenazate (Acramite 50WS) at 0.375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed one treatment.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Retreatment interval 7 days.
- etoxazole (Zeal) at 0.09 to 0.135 lb ai/a. PHI 7 days. REI 12 hr. Limit 1 treatment per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- *Isaria fumosorosea* (PFR-97 20% WDG) Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- malathion (Fyfanon 8) 1 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments for watermelon and 2 treatments for all others. Retreatment interval 7 days.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Melon (Cantaloupe, muskmelon, and watermelon)—Squash bug

*Anasa tristis*

**Pest description and crop damage** The squash bug attacks squash, pumpkin, melons, and related crops. Adults are typically dark brown, but may have gray or light brown markings. They are about 0.75 inch long at maturity. Squash bug nymphs and adults feed on the leaves, causing small yellow specks which later turn brown. Squash bugs also inject a toxin into vines, which causes a wilt from the point of attack to the end of the vine. Affected runners wilt and turn black and crisp. Small plants may be killed, while larger plants may lose several runners. Squash bugs also may attack young fruit.

**Biology and life history** Adult squash bugs overwinter in debris and sheltered places in the garden. Brown to reddish eggs are laid along the veins of new leaves. The newly hatched nymphs (immature bugs) are greenish to gray.

### Management—cultural control

Clean up debris in the fall to remove overwintering squash bugs. Hand-pick eggs, nymphs, and adults.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- esfenvalerate
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Do not make applications less than 7 days apart.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a soil, 0.15 to 0.2 lb ai/a foliar. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Do not exceed 0.09 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.234 lb ai/a per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days, REI 24 hr. Do not exceed 0.48 lb ai/a tebuconazole or 0.18 lb lambda cyhalothrin per season.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a . PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

## Melon (Cantaloupe, muskmelon, and watermelon)—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- diazinon (Diazinon 50W) at 3 to 4 lb ai/a broadcast and incorporate into top 4 to 8 inches prior to planting. REI 3 days.
- thiamethoxam as seed treatment.

## Mushroom

See:

Mushroom Pests

## Muskmelon—see Melon

## Mustard greens—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Green peach aphid (*Myzus persicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Biology and life history** Most species of aphids have similar life cycles. Aphid females give birth to live offspring all year without mating. When vegetable crops are not available, aphids live on a wide variety of weed hosts. In summer and fall, aphids may produce winged females and, later, winged males. They mate and produce eggs for overwintering, especially in colder climates. Otherwise, adult aphids overwinter on crops, weeds, or trees. There may be as few as two generations (the green peach aphid) or as many as 16 generations each year (the cabbage aphid), depending on the species and climate.

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not entering a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen. Roguing diseased plants early may help slow the spread of aphid-vectored diseases.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- horticultural oil—Some formulations OMRI-listed for organic use.
- imidacloprid
- lambda-cyhalothrin
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.375 lb ai/a per year or 4 applications per season.
- afidopyropen (Versys Inscalis) at 0.01 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 8 pints formulated product/a. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- dimethoate (Dimethoate 4E) at 0.25 lb ai/a. PHI 14 days. REI 48 hr. Retreatment interval 9 days. Do not exceed 0.5 lb ai/a per season.
- dinotefuran (Venom) at 0.088 to 0.131 lb ai/a PHI 1 day. REI 12 hr. Do not exceed 0.263 lb ai/a per season. Retreatment interval 7 days.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season. Limit 3 treatments.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. Retreatment interval 5 days. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.23 lb ai/a foliar per season.
- imidacloprid (Provado) at 0.0475 lb ai/a. PHI 7 days. REI 12 hr. Allow 5 days between foliar sprays. Do not use more than 0.23 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1.0 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season. A penetrating adjuvant improves performance.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.

- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Armyworm and looper

### Includes

Beet armyworm (*Spodoptera exigua*)  
 Bertha armyworm (*Mamestra configurata*)  
 Western yellowstriped armyworm (*Spodoptera praefica*)  
 Alfalfa looper (*Autographa californica*)  
 Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at planting. REI 12 hr. Do not exceed 0.4 lb ai/a per year at-plant plus foliar. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at plant, drip or foliar. PHI 3 days. REI 4 hr. Limit 4 treatments per year. Retreatment interval 3 days foliar, 10 days drip. Do not exceed 0.2 lb ai/a per season.

- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- cypermethrin (Holster) at 0.075 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- esfenvalerate (Asana XL) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Loopers only.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- malathion (Malathion 8) at 1.0 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 10 days. REI 48 hr. Do not exceed 3.6 lb ai/a or 8 treatments per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early-season application and 0.12 to 0.16 lb ai for mid to late-season application or heavy infestation. PHI 1 day. REI 4 hr. Adding adjuvant improves performance. Do not exceed 1 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.047 to 0.156 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed six applications or 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a for early season; 0.12 lb ai/a for mid to late season. PHI 7 days. REI 4 hr. Do not exceed 0.63 lb ai/a per crop. Retreatment interval 10 days. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Cabbage maggot

*Delia brassicae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate. If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments would be of little value. Sticky traps and sweep nets also can be used to monitor the adult fly.

### Management—biological control

Rove beetles prey on maggot eggs and young larvae. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp *Trybliographa rapae* lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

### Management—cultural control

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seedrow. It is believed that adult flies can locate the seed row for egg-laying by honing in on the higher moisture levels created when the soil is overturned for planting.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops, unless sufficient time has passed for the residue to dry or decompose completely.

### Management—chemical control: HOME USE

- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at planting. REI 12 hr. Do not exceed 0.1 lb ai/a per year at-plant plus foliar. Some formulations are prohibited in coastal counties..

## Mustard greens—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description and crop damage** The western spotted cucumber beetle is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white except for the head and last abdominal segment, which are brown. They are about 0.62 inch long. A close relative, the western striped cucumber beetle, is yellowish and has three black lines down its back. The larvae live in the soil where they feed on roots. Adults are foliage and flower feeders.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a at planting. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Allow at least 7 days between applications. Do not exceed 0.4 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Cutworm

### Includes

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

**Pest description and crop damage** The black cutworm moth is a uniform dark brown with a lighter irregular band near the wing tips and a distinct black dash. The wingspan is 1.5 to 2.12 inches long. Eggs are white at first, later turning brown. Larvae are a uniform gray to nearly black, lighter underneath, ranging from 0.19 inch to 2 inches as they pass through up to nine instars. The pupa is dark brown and about 0.75 inch long. Most feeding is at ground level at night, and plants are cut off at ground level. In the Willamette Valley, it is the most damaging cutworm species to vegetable crops. The last, largest instar does by far the most feeding, though middle instars can cut down seedlings.

Variegated cutworm moths are about 1 inch long with a wingspan of 1.25 to 2 inches. They vary widely in color. Eggs are white to dull or off-white and ribbed. They generally are deposited in massed rows on crop foliage but frequently are on weeds. Larvae are brownish gray to grayish black, up to 1.75 inches long when fully grown. Pupae are mahogany brown and about 0.75 inch long. The variegated cutworm feeds readily on a wide variety of crops and climbs into the host plant to feed. Cutworms are most active and cause the most damage during spring and early summer.

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control.

- azadirachtin (neem oil)—Some formulations are OMRI-listed.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually a mix with zeta-cypermethrin).
- carbaryl

- cyfluthrin
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at planting. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Some formulations are
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- carbaryl (Sevin 5 Bait) at 2 lb ai/a as granule. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments. Do not exceed 6 lb ai/a per season.
- chlorpyrifos (Lorsban Advanced) at 2.11 lb ai/a soil applied. REI 24 hr. **RESTRICTED USE IN OREGON.**
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/a. Broadcast just before planting and immediately incorporate into the soil. REI 4 days. One soil treatment per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Diamondback moth

### *Plutella xylostella*

**Pest description and crop damage** Diamondback larvae are smaller than most other caterpillars in cole crops, about 0.31 inch when full grown. The larval body is wider in the middle and tapers at both ends, with two legs (prolegs) on the last segment forming a distinctive V-shape at the rear end. When disturbed, the larvae wiggle frantically or rapidly attach a silken line to a leaf and drop over the edge. They feed mostly on outer or older leaves of older plants, chewing out small holes, or at the growing points of young plants. They also feed on floral stalks and flower buds. Adult moths are small, slender, and grayish brown. Male moths display three diamond-shaped markings on their back. In the Pacific Northwest, the damage from diamondback moth is not so much from feeding as from contamination by pupae. Late stage instars crawl into stems infesting harvested crops.

**Biology and life history** Cabbage is the preferred host, but it also attacks all cole family crops. The adult overwinters in trash in and around fields. Adults emerge in May and early June and lay eggs singly or in twos or threes mainly on the upper sides of leaves. The eggs are minute. They hatch in 4 to 8 days. Larvae feed mostly on the undersides of outer or older leaves of older plants, chewing out small holes, and mature in 10 to 30 days. They then spin loose white cocoons, which they attach to leaves or stems, and pupate within them. Adults emerge in 10 to 14 days. There may be two to four overlapping generations each year.

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

#### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, take into account the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

#### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl

- cyfluthrin
- lambda-cyhalothrin
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season. Larvae only.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at plant, drip or foliar. PHI 3 days. REI 4 hr. Limit 4 treatments per year. Retreatment interval 3 days foliar, 10 days drip. Do not exceed 0.2 lb ai/a per season. Consult label for application details.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 10 days. REI 48 hr. Do not exceed 3.6 lb ai/a per season. Limit 8 treatments.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.023 to 0.0625 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Flea beetle

**Includes** cabbage flea beetle (*Phyllotreta cruciferae*)

**Pest description and crop damage** Flea beetle adults are metallic greenish brown to black in color and from 0.06 to 0.12 inch long. They derive their name from their well-developed hind legs; when disturbed, they jump like fleas. The larvae live in the soil, are slender, whitish, and about 0.25 inch long when mature. Adult beetles chew small holes in leaves, giving them a sievelike appearance. The cotyledons of emerging seedlings are especially susceptible to damage. The larvae feed on underground parts of the plant. High populations of flea beetles feeding on seedling plants can result in stand loss. Foliar damage to mature plants is not considered to be damaging economically. Flea beetles contribute to the spread of various plant diseases.

**Biology and life history** Most flea beetle species have similar life cycles. Adults overwinter in trash around field margins. They become active in late March through May. Flea beetles lay their very small eggs in May in the soil around the plant, on the leaves, or in cavities hollowed out in stems. The larvae feed on the foliage, mine the leaves, or attack the roots, depending on the species, usually from June to mid July, when pupation in the soil

occurs. Adults emerge from July through early September and feed a short time before overwintering in trash around field margins. Depending on the species, there are one or two generations each year.

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours.

Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 feet of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

#### **Management—cultural control**

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Allow at least 7-days between applications. Do not exceed 0.4 lb ai/a per season.
- dinotefuran (Venom) at 0.088 to 0.131 lb ai/a PHI 1 day. REI 12 hr. Do not exceed 0.263 lb ai/a per season. Retreatment interval 7 days.
- malathion (Malathion 8) at 1.0 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days.
- imidacloprid (Admire Pro) at 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/a foliar per season. No soil application for flea beetle.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.

- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Imported cabbageworm

*Pieris rapae*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** The following information is from California but is generally applicable in the Pacific Northwest: Cabbageworms can be monitored at the same time as cabbage loopers. Sample 25 plants selected randomly throughout the field. Although treatment levels combine the two species, cabbageworms may be harder to find because of their smaller size and their inconspicuous coloring. Look for small larvae and eggs on the undersides of leaves. Larger worms feed toward the center of the plant, often near the midribs of leaves. Good clues to cabbageworm presence include their greenish brown fecal pellets, or many white cabbage butterflies fluttering around the field (check for eggs in a few days).

Base treatment on numbers of healthy larvae present. Treat seedlings or small plants if populations of medium-size to large caterpillars are high enough to stunt growth. Prior to heading, well-established plants do not need to be treated unless you find more than nine small to medium-size larvae per plant.

### Management—biological control

Natural enemies can assist significantly in the control of imported cabbageworm. Important parasites include the pupal, larval, and egg parasites in the *Trichogramma* genus, as well as tachinid flies. Timely mass releases of commercially available trichogramma during peak flight can be an effective control agent. Viruses and bacterial diseases are also sometimes important control factors in the field.

Where possible, use *Bacillus thuringiensis* (*Bt*) to avoid adverse impact on natural enemies. *Bt* is very effective against imported cabbageworm, especially when applied to young (early-instar) caterpillars.

### Management—cultural control

Make new plantings as far as possible from those of the previous year. At the end of the year, harvest crops without delay. Plowing under or destroying plant residues at this time eliminates an important food source for the overwintering generation of cabbageworms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.095 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments after bloom. Do not exceed 0.24 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin.

- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at plant, drip or foliar. PHI 3 days. REI 4 hr. Limit 4 treatments per year. Retreatment interval 3 days foliar, 10 days drip. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 3 treatments. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- cypermethrin (Holster) at 0.05 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Allow at least 7-days between applications. Do not exceed 0.4 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.0075 to 0.015 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- esfenvalerate (Asana XL) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season.
- malathion (Malathion 8) at 1.0 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 10 days. REI 48 hr. Do not exceed 3.6 lb ai/a per season. Limit 8 treatments per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early-season application; at 0.12 to 0.16 lb ai/a for mid- to late-season application or heavy infestation. REI 4 hr. PHI 1 day. Adding adjuvant improves performance. Do not exceed 1 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.047 to 0.09 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a for early season; 0.12 lb ai/a for mid to late season. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.63 lb ai/a per season. Retreatment interval 10 days. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Mustard greens—Wireworm

*Limoni* spp.

**Pest description and crop damage** Wireworms are the soil-dwelling larvae of click beetles. Adult click beetles are slender, tan to nearly black, and about 0.37 inch long. Larvae are hard, segmented, 0.37 to 0.5 inch long and dark yellow or brown. They resemble mealworms. Wireworms injure seedlings by feeding on roots, tubers, or bulbs, or boring into stems. Damage is more common in spring planted crops where the soil has a high organic content, such as fields that recently have been in or adjacent to alfalfa, pasture, or uncontrolled weeds. Wireworms do not significantly damage older plants.

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at planting. REI 12 hr. Do not exceed 0.4 lb ai/a per year at-plant plus foliar.
- chlorpyrifos (Lorsban Advanced) at 2.11 lb ai/a soil applied. REI 24 hr.
- diazinon (Diazinon 50W)—Broadcast just before planting at 3 to 4 lb ai/a and immediately incorporate into the top 4 to 8 inches of soil. REI 4 days.

# Onion—Armyworm and cutworm

## Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)

## Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

## Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

## Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- deltamethrin
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. Small armyworms only. Use a spreader-sticker to enhance control. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments per season.
- cypermethrin (Holster) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Do not graze or feed crop residues to livestock.
- deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.112 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a for cutworms and 0.01 to 0.015 lb ai/a for armyworms. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves control.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a for cutworm; or 0.02 to 0.03 lb ai/a for armyworm. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not graze or feed to livestock. Do not exceed 0.24 lb ai/a per season. An oil or surfactant adjuvant improves control.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed, per season, 5.4 lb ai/a on green onion and 3.6 lb ai/a on dry bulb onion. Limit 8 treatments per season. Retreatment interval 5 days.
- permethrin (Ambush 25WP, Pounce 25WP) at 0.15 to 0.3 lb ai/a for armyworm and 0.1 to 0.3 lb ai/a for cutworm. PHI 1 day. REI 12 hr. Do not exceed 2 lb ai/a per season. Do not feed culls or graze.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed five applications or 0.234 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb i/a per season. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per year.

## Onion—Brown wheat mite

*Petrobia latens*

**Pest description and crop damage** The brown wheat mite is tiny, dark, and less than 0.03 inch long, with front legs longer than the body. Feeding mottles the leaves, giving them a bronzed, silvery, or (later) scorched appearance. Host plants include cereals, onions, carrots, alfalfa, iris, and gladiolus.

**Pest monitoring** Chemical controls are not generally recommended. However, application of chemicals for aphid control may lead to a build-up of mites, leading to the occasional need for an acaricide.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- sulfur

### Management—chemical control: COMMERCIAL USE

- sulfur (Microthiol Disperss) at 3 to 10 lb product/a. PHI 0 days. REI 24 hr.

## Onion—Bulb mite

*Rhizoglyphus* spp.

**Pest description and crop damage** Bulb mites are shiny, creamy white, bulbous, and about 0.03 inch long. They are generally in clusters, in damaged areas under the root plate of onion bulbs or garlic cloves. They have a wide host range, feed on many kinds of bulbs, roots, and tubers, and can infest bulbs in storage or in the field. Bulb mites can survive on decaying vegetation in the field until it is completely decomposed.

Bulb mites damage bulbs by penetrating the outer layer of tissue and allowing rot organisms to gain entry. This pest is most damaging when plant growth is slowed by mild, wet weather. Bulb mites can reduce plant stands, stunt plant growth, and promote rot of bulbs in storage. On seeded onions, they can cut off the radicle before the plant becomes established.

**Pest monitoring** No specific monitoring methods are available. Use a microscope to examine fragments of undecayed vegetation in the soil or volunteer onions or garlic for the presence of the mites. Treatments generally are preventive and should be considered for fields that are high in vegetative matter or that have had previous bulb mite problems. No treatment thresholds exist.

### Management—cultural control

Rapid rotation, from one crop to the next, fosters survival of mites on the leftover vegetation in the soil from the previous crop. Decaying cole crops, especially cauliflower, may harbor very high bulb mite populations. Fallow fields to allow organic matter to decompose completely; this reduces field populations of the mite. Avoid planting successive onion or garlic crops. Flood irrigation or heavy rains during the winter may reduce mite levels in the soil. Garlic growers must insist on clean seed cloves. Hot-water treatment of seed garlic before planting may reduce mite infestation. If onions are being grown from transplants, closely inspect transplants prior to planting as bulb mites can be brought in on transplants.

### Management—chemical control: HOME USE

None registered.

### Management—chemical control: COMMERCIAL USE

- Soil fumigation can help to control this pest.

## Onion—Leafminer

### Includes

American serpentine leafminer (*Liriomyza trifolii*)

Pea leafminer (*Liriomyza huidobrensis*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long, stiff bristles. Larvae are a nearly translucent white or yellow and about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups. Adult leafminers may stunt seedlings by attacking the cotyledons in seeds. Larvae mine between upper and lower leaf surfaces, creating winding, whitish tunnels that initially are narrow but then widen as the larvae grow. Excessive mining renders leaves unmarketable, reduces photosynthetic capacity, and provides easy access for disease organisms.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- deltamethrin
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin

- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-mek 0.15) at 0.009 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.019 lb ai/a per season. Retreatment interval 7 days.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Rotate with other modes of action. Begin applications early for best results. Do not exceed 0.4 lb ai/a per season.
- cyantraniliprole + abamectin (Minecto Pro) at 7 to 10 fl oz/a. PHI 30 days. Do not apply more than two times in a row. Retreatment interval 7 days. Do not apply more than 20 fl oz/a per season (0.18 lb ai/a of cyantraniliprole and 0.038 lb ai/a of abamectin).
- cypermethrin (Holster) at 0.04 to 0.1 lb ai/a. PHI 7 days for dry bulb onion only. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Do not graze or feed crop residues to livestock. Wait 30 days to plant rotational crops.
- cyromazine (Trigard) at 0.125 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not apply more than 6 applications per crop.
- dinotefuran (Scorpion 35SG) at 0.135 to 0.18 lb ai/a foliar; 0.225 to 0.27 lb ai/a soil. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not apply more than 0.266 lb ai/a per crop.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves control.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 14 days. REI 24 hr. Do not exceed 0.24 lb ai/a per season. Retreatment interval 5 days. An oil or surfactant adjuvant improves control.
- permethrin (Pounce 25W, Ambush 25W) at 0.1 to 0.3 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2 lb ai/a per season. Do not feed culls or graze.
- spinetoram (Radiant SC) at 0.0468 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 5 applications or 0.234 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb i/a per season. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Adults only. Do not exceed 0.25 lb ai/a per season. Do not graze livestock or cut for feed.

## **Onion—Onion maggot and seedcorn maggot**

### **Includes**

Onion maggot (*Delia antiqua*)

Seedcorn maggot (*Delia platura*)

**Pest description and crop damage** Onion maggot eggs are white, elongated, and about 0.04 inch long and are laid on the soil near the stem and occasionally on the young leaves and neck of the onion plant. The legless maggots are tapered, creamy white, and reach a length of about 0.031 inch. The pupa is chestnut brown and about 0.031 inch long. Adult onion flies are slightly smaller than houseflies. They have longer legs, are more slender, and overlap their wings when at rest. Onion maggot larvae attack germinating seedlings, feeding on the developing roots and epicotyl, and can continue to feed on the expanding bulbs during later stages of growth. This results in increased rot in bulbs held in storage.

The seedcorn maggot adult is a slender, light gray fly, about 0.19 inch long. It looks much like a small housefly. The whitish eggs have slightly raised ridges running the length and width of the eggs forming tiny rectangles. Larvae are about 0.25 inch long, white to whitish yellow, cylindrical, and tapered, with the smaller end in front. Pupae are small brown capsules. The seedcorn maggot is abundant during or following a wet cycle, primarily in spring, and is most common in fields containing a high amount of residue from a previous crop or where manure has been spread. Seedcorn maggot damage usually is restricted to the very early seedling stage. Maggots are primarily a pest of onion and do not generally cause economic damage to garlic. They may spread bacterial soft rot.

**Biology and life history** Three overlapping generations of onion maggot occur each year. Onion maggot overwinters as a pupa in the soil, although some adults may survive in protected areas. Emergence occurs in the spring and typically extends from April to June. Second or summer generation flies are active from late June to early August. A third flight can take place from early August to October. The adults spend little time within the fields during the day, preferring to rest at field margins in taller and denser vegetation. The flies are most active in onion fields during dusk and dawn or on overcast days. Onion maggot damage is greatest after consecutive years of wet springs.

The seedcorn maggot overwinters as a pupa in the soil. Adults emerge in early May and lay eggs singly or in clusters in the soil near plant stems. They prefer soils with high levels of organic matter. Eggs hatch in 7 to 10 days. Larvae feed for 1 to 3 weeks on seeds and germinating seedlings and then burrow into the soil to pupate. They emerge as adults in late June and early July. Adults lay eggs as before, and larvae feed to maturity and pupate in August to form the overwintering stage. There may be as many as five generations each year. It can be a significant pest of onion in some years in the Columbia Basin.

**Pest monitoring** Slow emergence and poor stand establishment are signs of maggot activity. Where slow, spotty emergence is observed, dig up seed and inspect it for maggot feeding. Cool soil temperature and periods of excessive moisture favoring slow seed germination and seedling emergence increase susceptibility to maggot infestation. To assess potential infestation levels prior to planting, place a cut potato or other vegetable or fruit in the field and apply baker's yeast with some water to the cut surface. Leave the bait for several hours and return to look for the presence of adult

seedcorn maggot flies as they are attracted to carbon dioxide.

In the Pacific Northwest, no specific monitoring methods have been developed. In other parts of the country, estimates of adult fly activity are obtained from the use of yellow or white sticky traps, water pan traps, and pyramid traps to assist in determining the necessity and timing of treatments. Treatments for onion and seedcorn maggot are preventive and should be considered for fields that are high in organic matter or undecomposed organic material or that have had previous maggot problems.

### Management—cultural control

Avoid planting in soils that are high in undecomposed organic matter, such as fields just coming out of pasture or very weedy situations. Use herbicides to kill cover crop strips 3 to 4 weeks before seeding. In soils amended with animal manures, allow adequate time for the manure to break down before planting.

Avoid planting successive rotations of onion crops. Early spring-planted crops are more likely to be damaged when the soil is too cool for rapid germination and emergence.

If serious infestations are expected, wait until the soil warms up in spring, or, if feasible, plant in fall while the soil is still warm. When planting, use a chain drag or similar implement behind the drill to cover the seed row. Consider planting into a “stale” seedbed. Use an appropriate insecticide in the seed box at planting if problems are expected.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chlorpyrifos (Lorsban 4E) at 0.03 lb ai/1,000 ft in furrow or at 1 lb ai/a as a directed spray to the base of the onion plants. PHI 60 days. REI 24 hr. Do not exceed two applications per season. 24c SLN ID-010001. **RESTRICTED USE IN OREGON.**
- clothianidin/imidacloprid (Sepresto)—Seed treatment. See label for more information.
- cypermethrin (Holster) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. An oil or surfactant adjuvant improves control. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Do not graze or feed crop residues to livestock. Spray at dusk along the edges of onion fields as flies migrate back into the fields to lay eggs. Wait 30 days after harvest before planting a subsequent crop.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/a. Broadcast before planting and incorporate into the top 3 to 4 inches. REI 3 days.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves control.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Adults of onion and seedcorn maggot. Bulb onion only. Do not exceed 0.24 lb ai/a per season.
- malathion (Fyfanon 8E) at 1.56 lb ai/a. PHI 3 days. REI 12 hr. Use for adult control. Use on direct-seeded dry bulb onions only. Apply as an in-furrow drench at seeding. Use at least 40 gal/a of spray. Limit 2 treatments. Retreatment interval 7 days.
- permethrin (Ambush 25WP, Pounce 25WP) at 0.1 to 0.3 lb ai/a. PHI 1 day. REI 12 hr. For adult fly control. Do not exceed 2 lb ai/a per season.
- thiamethoxam (Cruiser 70S)—Seed treatment. See label for more information.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Adult fly control. Spray near dusk when flies reenter field. Do not exceed 0.25 lb ai/a per season. Do not graze livestock or cut for feed.

## Onion—Thrips

### Includes

Onion thrips (*Thrips tabaci*)

Western flower thrips (*Frankliniella occidentalis*)

### Pest description and crop damage

See:

Common Pests of Vegetable Crops

Thrips infestations can reduce onion yield by as much as 20%. Onion thrips also vector Iris Yellow Spot Virus. Onion thrips thrive in hot, dry conditions and are usually more damaging where these conditions prevail most of the production year.

### Biology and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Although thrips feeding during the early bulbing stage is the most damaging to yields, thrips must be controlled before onions

reach this stage. Otherwise, populations might exceed levels that can be controlled adequately.

In California, a reliable means of evaluating thrips populations is to randomly sample entire onion plants. Larva stages tend to congregate around the newest leaves of the plant. Sample at least five plants from four separate areas of the field. Early in the season, an average of 2 thrips per plant warrants control measures. A threshold of 20 thrips per plant mid-year (lower for very young plants and higher for larger mature plants) has been used successfully for dry bulb fresh market and drying onions. The marketability of green onions (those marketed fresh with the leaves attached) is severely reduced by thrips scarring. Apply treatments at the first sign of thrips feeding.

#### **Management—cultural control**

Avoid planting onions near grain fields, if possible, because thrips numbers often build up in cereals in spring. Onion grown with overhead irrigation tend to have lower thrips numbers as thrips tend to be washed from the plant to some extent with heavy irrigation or rains.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- deltamethrin
- gamma-cyhalothrin
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

Thorough coverage is essential for control, as most thrips feed in protected areas of the plant.

- abamectin (Agri-Mek 0.15EC ) at 0.009 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.019 lb ai/a per season.
- acetamiprid (Assail SG) at 0.094 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 3 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Rotate with other modes of action. Begin applications early for best results. Do not exceed 0.4 lb ai/a per season.
- cyantraniliprole + abamectin (Minecto Pro) at 7 to 10 fl oz/A. PHI 30 days. Do not apply more than two times in a row. Retreatment interval 7 days. Do not apply more than 20 fl oz/A per season (0.18 lb ai/a of cyantraniliprole and 0.038 lb ai/a of abamectin).
- cypermethrin (Holster) at 0.08 to 0.1 lb ai/a. PHI 7 days. Dry bulb onion only. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Do not graze or feed crop residues to livestock.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.112 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.010 to 0.015 lb ai/a. PHI 14 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.12 lb ai/a per season. An oil or nonionic surfactant improves control.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 14 days. Bulb onion only. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season. An oil or surfactant adjuvant improves control.
- *Metarhizium anisopliae* at 40 to 80 fl oz/100 gal as drench or 0.25 to 2 quarts/a. PHI 0 days. REI 4 hr.
- methomyl (Lannate SP) at 0.9 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed, per season 5.4 lb ai/a for green onion or 3.6 lb ai/a for dry bulb onion. Limit 8 treatments per season. Retreatment interval 5 days.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a. PHI 14 days. REI 48 hr. Dry bulb only. Do not harvest tops. Do not exceed 4.5 lb ai/a per season. Suppression only.
- permethrin (Ambush 25WP) at 0.15 to 0.3 lb ai/a. PHI 1 day. REI 12 hr. Dry bulb onion only. Do not exceed 2 lb ai/a per season.
- pyriproxyfen (Knack) at 0.067 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.134 lb ai/a per season. Retreatment interval 14 days.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed five applications or 0.234 lb ai/a per season. Follow resistance management procedures on the label.
- spinosad (Success) at 0.063 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb i/a per season. For suppression. Some formulations are OMRI-listed for organic use.
- spirotetremat (Movento) at 5 fl oz/a. PHI 3 days. Retreatment interval 7 days. REI 24 hr.
- tolfenpyrad (Torac) at 0.24 lb ai/a. PHI 7 day. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 0.73 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.0375 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not graze or cut for feed. Do

not exceed 0.25 lb ai/a per season.

**Pesticide resistance management** Resistance to organophosphate and pyrethroid insecticides has been documented in several states and is suspected in California. For this reason, alternate insecticides from different chemical families when multiple treatments are needed during a year. Be sure to use surfactants when recommended by the label as thrips reside down in the neck of the onion plant and contact of the chemistry to thrips is important.

## Onion—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- dichloropropene (Telone II)—Preplant.
- diazinon at 3 to 4 lb ai/a. Broadcast before planting and incorporate into the top 4 to 8 inches. REI 3 days.

## Parsley—Aphid

**Includes** green peach aphid (*Myzus persicae*)

### Pest description, crop damage and life history

*See*

Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 0.375 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season. Turnip-rooted parsley only.

- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Limit 4 treatments. Turnip-rooted parsley only.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 2 to 3 quarts formulated product per acre. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar and 0.15 to 0.2 lb ai/a at plant. PHI 7 foliar, 21 days at plant. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 7 days foliar and 21 day for soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil and 0.043 lb ai/a foliar. PHI 21 days soil; 7 days foliar. Retreatment interval 5 days. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season.
- imidacloprid (Provado, Prey) at 0.048 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- *Isaria fumosorosea* (PFR-97 20% WDG)—Most effective when application is initiated just before or at the first signs that target pests are present. OMRI-listed for organic use.
- malathion (Malathion 8) at 1.5 lb ai/a. PHI 7 days. REI 24 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season. A penetrating adjuvant improves performance.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season. Apply to the soil as in-furrow spray, band application, drench, shanked or with irrigation.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not graze or cut for feed. Do not exceed 0.3 lb ai/a per season.

## Parsley—Armyworm, cutworm, and looper

### Includes

Beet armyworm (*Spodoptera exigua*)  
 Bertha armyworm (*Mamestra configurata*)  
 Western yellowstriped armyworm (*Spodoptera praefica*)  
 Black cutworm (*Agrotis ipsilon*)  
 Variegated cutworm (*Peridroma saucia*)  
 Alfalfa looper (*Autographa californica*)  
 Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* ssp. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb ai/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. An adjuvant improves control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Turnip-rooted parsley only.
- borate complex (Prev-Am Ultra) apply as 0.8% solution to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 0.5 to 2 lb ai/a. PHI 14 days leafy; 7 days rooted. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per season. Limit 5 treatments per year. Armyworm only.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.065 to 0.11 lb ai/a. PHI 3 days REI 12 hr. Do not exceed 0.44 lb ai/a per crop. Retreatment interval 3 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 10 days. REI 48 hr. Do not exceed 3.6 lb ai/a per season. Limit 8 treatments.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early season; 0.12 to 0.16 lb ai/a mid and late season. PHI 1 day. REI 4 hr. Retreatment interval 10 to 14 days. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin, Permethrin Cutworm Bait) at 0.05 to 0.2 lb ai/a foliar spray or 0.1 to 0.2 lb ai/a as bait. PHI 1 day. REI 12 hr. Do not graze. Retreatment interval 3 days. Do not exceed 0.2 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust) at 0.063 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-season; 0.12 lb ai/a mid- to late-season. PHI 7 days. REI 4 hr. Do not exceed 0.63 lb ai/a per season. Retreatment interval 10 days. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments. Do not exceed 0.42 lb ai/a per year. Suppression.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a for cutworm, and 0.04 to 0.05 lb ai/a for armyworm and looper. PHI 1 day. REI 12 hr.

Retreatment interval 7 days. Do not graze or cut for feed. Do not exceed 0.3 lb ai/a per season.

## Parsnip—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Willow-carrot aphid (*Cavariella aegopodii*)

**Pest description and crop damage** The willow-carrot aphid is green to greenish yellow. Its primary host is willow, but it feeds on carrots during the summer. The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Infestations may result in wilting. The bean aphid is dark olive green to black with light-color legs. It is usually more of an early-year pest.

Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases such as alfalfa mosaic, tomato yellow top, and zucchini yellow mosaic (a large number of viruses are spread by aphids). Infestations frequently are localized, with heavily infested leaves curled downward.

### Biology and life history

See

Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- imidacloprid
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr (ES) or 12 hr (WP). OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply 0.8% solution to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.091 to 0.137 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil; 0.043 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season. Retreatment interval 5 days foliar.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 3 treatments per year.
- sulfoxafloflor (Transform WG) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 24 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a. REI 12 hr. Do not exceed 0.188 lb ai/a per season. Apply to the soil as in-furrow spray,

band application, drench, shanked or with irrigation.

- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

## Parsnip—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. An adjuvant improves control. Small larvae only. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- borate complex (Prev-Am Ultra) apply 0.8% solution to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 0.2 lb ai/a per season. Limit 4 treatments.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.018 to 0.028 ai/a for armyworms, and 0.012 to 0.028 lb ai/a for cutworms. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early season; 0.12 to 0.16 lb ai/a mid to late season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 3 days. Retreatment interval 4 days. Do not exceed 0.219 lb ai/a per season. Limit 4 treatments per season. Armyworms only.
- spinosad (Success, Entrust SC) at 0.063 to 0.125 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.47 lb ai/a per season. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

## Parsnip—Carrot rust fly

*Psila rosae*

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

**Pest monitoring** Orange or yellow sticky traps can be used to monitor for carrot rust fly. In Ontario, Canada, an action threshold of one-tenth to two-tenths flies per trap per day is used. Degree-day accumulations have been calculated for carrot rust fly development.

Begin monitoring at the second leaf stage. Symptoms of larval attack are wilting and discolored (“rusty”) foliage, especially in dry weather. Less severely damaged plants appear stunted.

### Management—cultural control

Rotating crops plays an important role in reducing populations of this pest. Destroy volunteer carrots and all umbelliferous plants, as they may serve as alternate hosts and possible sources of infestation. Early harvest helps control damage. If early harvest is not possible, harvest in blocks rather than selectively. Deep plowing in fall or spring can be helpful. Floating row covers work very well and may be cost effective on high value crops.

### Management—chemical control: HOME USE

None registered.

### Management—chemical control: COMMERCIAL USE

None registered.

## Parsnip—Flea beetle

**Includes** *Epitrix* spp.

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- imidacloprid
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 7 days. REI 12 hr. Allow at least 7 days between applications. Do not exceed six applications or 6 lb ai/a per season. Limit 5 treatments.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil; 0.043 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season. Retreatment interval 5 days foliar.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 3 treatments per year
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.187 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.187 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.3 lb ai/a per year. Retreatment interval 7 days.

## Parsnip—Leafhopper

**Includes** six-spotted leafhopper (*Macrostelus quadrilineatus*)

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

**Pest monitoring** Leafhoppers are collected easily with sweep nets. Yellow sticky traps also can be used to monitor.

#### **Management—cultural control**

Destruction of weed species known to harbor aster yellows is important.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin.—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 7 days. REI 12 hr. Allow at least 7 days between applications. Do not exceed 6 lb ai/a per season. Limit 5 treatments per season.
- *Chenopodium ambrosioides* (Requiem Prime) at 4 to 8 pints/a. PHI 0 days. REI 4 hr.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil; 0.043 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.13 lb ai/a foliar per season. Retreatment interval 5 days foliar.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 3 treatments per year
- sulfoxaflor (Transform WG) at 0.047 to 0.086 lb ai/a. PHI 7 days. REI 24 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.187 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.187 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

## **Pea, green and dry—Aphid**

**Includes** pea aphid (*Acyrtosiphon pisum*)

**Pest description and crop damage** The pea aphid is a relatively large, green, somewhat shiny species. It is an efficient vector of plant viruses. Populations tend to build in spring, decline in summer, and build again in the fall. Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases (a large number of viruses are spread by aphids). Infestations frequently are localized, with heavily infested leaves curled downward. Aphids also feed on pea pods, reducing pod yields.

#### **Management—cultural control**

Plant enation-resistant peas. These varieties include 'Almoto,' 'Aspen,' 'Aurora,' 'Citation,' 'Corvallis,' 'Freezer 50,' 'Green Sugar,' 'Knight,' 'Mohawk,' 'Oregon Sugar Pod,' 'Perfected Freezer 60,' and 'Prospector.' Plant early, before March 31, to avoid aphid infestations. Controlling weeds late in the season may help reduce overwintering populations. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

Home gardeners: Use row covers or wash aphids from plants with a strong stream of water.

#### **Management—chemical control: HOME USE**

- acetamiprid—Not for use on green peas.
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- esfenvalerate
- kaolin—Applied as a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- imidacloprid

- insecticidal soap—Some formulations OMRI-listed for organic use.
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.044 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Succulent shelled peas only.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- borate complex (Prev-Am) apply 0.8% solution to complete coverage. PHI 12 hr. REI 12 hr. OMRI-listed for organic use.
- cyfluthrin (Baythroid 2, Tombstone) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- dimethoate (numerous products) at 0.167 to 0.50 lb ai/a. Do not exceed 0.5 lb ai/a per season. PHI 5 days succulent at 0.167 lb ai/a, 14 days for succulent at 0.25 lb ai/a or greater, and 14 days for dry peas. REI 48 hr. Do not graze. 24c SLN ID-970008, ID-98008, ID-970011, ID-970012, ID-010002, OR-050019, WA-970029.
- esfenvalerate (Asana) at 0.03 to 0.05 lb ai/a. PHI 3 days for green peas and 21 days for dry peas. REI 12. Do not exceed 0.2 lb ai/a per season for dry peas or 0.1 lb ai/a per season for green peas. Do not feed treated vines to livestock. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- flupyradifurone (Sivanto) at 7 to 10.5 fl oz/a. PHI 21 days. REI 4 hr. Do not exceed 0.365 lb ai/a per year. Minimum of 10 days between successive applications.
- imidacloprid (Admire) at 0.25 to 0.375 lb ai/a. PHI 21 days. Soil application only. REI 12 hr. Apply in-furrow or by chemigation. See label directions. Do not exceed 0.38 lb ai/a per season.
- imidachloprid (Gaucho 480F) at 0.063 to 0.125 lb ai/cwt seed prior to planting.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for succulent peas, 21 days for dry peas. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- malathion (numerous products) at 0.94 to 2.5 lb ai/a. PHI 3 days. Do not graze or feed to livestock. REI 12 hr.
- methomyl (Lannate) at 0.45 to 0.9 lb/a. PHI 1 day for harvest, 5 days for forage, and 14 days for hay—green only. REI 48 hr. Do not exceed six applications per crop or 2.7 lb ai/a per season.
- naled (Dibrom) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Processing peas only. Do not feed vines. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.04 to 0.05 lb ai/a (Mustang) or 0.2 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas and 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) 0.015 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Pea, green and dry—Armyworm and cutworm

#### Includes

Beet armyworm (*Spodoptera exigua*)  
 Bertha armyworm (*Mamestra configurata*)  
 Western yellowstriped armyworm (*Spodoptera praefica*)  
 Black cutworm (*Agotis ipsilon*)  
 Variegated cutworm (*Peridroma saucia*)

#### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

#### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

#### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- esfenvalerate

- gamma-cyhalothrin—Not for use on dry peas.
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- *Bacillus thuringiensis* (Javelin)—See product label for rates. PHI 0 days. REI 4 hr. Armyworms only. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Less effective in cool weather, when larvae feed slowly. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- carbaryl (Sevin) at 1 to 1.5 lb ai/a. PHI 3 days for harvest of succulents, 21 days for dried, 14 days for forage, and 21 days for hay. REI 12 hr. Do not exceed 6 lb ai/a per season. Control is more effective against cutworm species that feed on the upper parts of the plant.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- diazinon at 2 to 4 lb ai/a broadcast before planting and incorporate into the soil. REI 3 days. Succulent peas only.
- esfenvalerate (Asana) at 0.03 to 0.05 lb ai/a. PHI 3 days green peas and 21 days dry peas. REI 12 hr. Do not exceed 0.2 lb ai/a (dry peas) or 0.1 lb ai/a (green peas) per season. Do not feed treated vines to livestock. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- gamma-cyhalothrin at 0.0075 to 0.015 lb ai/a. PHI 7 days edible podded and succulent shelled peas, and 21 days for dry shelled peas. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 7 days for succulent peas, 21 days for dry peas. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate) at 0.45 to 0.9 lb/a. PHI 1 day for harvest, 5 days for forage, and 14 days for hay—green only. REI 48 hr. Do not exceed six applications per crop or 2.7 lb ai/a per season.
- methoxyfenozide (Intrepid) at 0.06 to 0.12 lb ai/a early season or 0.12 to 0.25 lb ai/a mid to late season. PHI 7 days. REI 4 hr. Do not exceed 1 lb ai/a per season. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.0391 to 0.0781 lb ai/a. PHI 28 days for dry peas, 3 days for fresh peas. Retreatment interval 4 days. REI 4 hr. Do not exceed six applications or 0.94 lb ai/a per season. Follow resistance management procedures on the label. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Armyworms only.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 3 days for succulent peas and 28 days for dry peas. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/a per season for green peas or 0.188 lb ai/a for dry peas. Do not feed forage or hay to livestock. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Do not feed forage or hay to livestock. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.04 to 0.05 lb ai/a for armyworms and 0.016 to 0.05 for cutworms (Mustang) or (Mustang) or 0.2 to 0.25 lb ai/a for armyworms and 0.008 to 0.025 lb ai/a for cutworms (Mustang Max). PHI 1 day for succulent peas and 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

**Pea, green and dry—Grasshopper**

Various species

**Pest description, crop damage and life history**

See

Common Pests of Vegetable Crops

**Management—chemical control: HOME USE**

Follow information on the label about the timing and cutoff date for spraying the particular vegetable you are treating. Spray damaged plants and any grass or weeds surrounding the vegetable garden when young hoppers or winged adults are seen.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- esfenvalerate
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season.

- bifenthrin (Capture, Sniper) at 0.025 to 0.1 lb ai/a. PHI 3 days for succulent only. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- carbaryl (Sevin) at 0.5 to 1.5 lb ai/a. PHI 3 days for succulents, 21 days for dried, 14 days for forage, 21 days for hay. REI 12 hr. Retreatment interval 7 days. Pest not specified on label.
- cyfluthrin (Baythroid 2, Tombstone) at 0.038 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- esfenvalerate (Asana) at 0.03 to 0.05 lb ai/a. PHI 3 days for green peas, 21 days for dry peas. REI 12 hr. Do not feed treated vines to livestock. Byproduct waste at processing plants may be fed to livestock. Do not exceed 0.2 lb ai/a (dry peas) or 0.1 lb ai/a (green peas) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- gamma-cyhalothrin (Proaxis) at 0.0075 to 0.015 lb ai/a. PHI 7 days edible podded and succulent shelled peas, and 21 days for dry shelled. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for succulent peas and 21 days dry peas. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.04 to 0.05 lb ai/a (Mustang) or 0.2 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas, 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Pea, green and dry—Leafminer

**Includes** pea leafminer (*Liriomyza huidobrensis*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long stiff bristles. Larvae are a nearly translucent white or yellow color, about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups. Adult leafminers may stunt seedlings by attacking the cotyledons in seeds. Larvae mine between upper and lower leaf surfaces, creating winding, whitish tunnels that initially are narrow but then widen as the larvae grow. Excessive mining renders leaves unmarketable as salad greens, reduces photosynthetic capacity, and provides easy access for disease organisms.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- naled (Dibrom) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Radiant SC) at 0.0391 to 0.0781 lb ai/a. PHI 28 days for dry peas, 3 days for fresh peas. Retreatment interval 4 days. REI 4 hr. Do not exceed six applications or 0.94 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Follow resistance management procedures on the label.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 3 days for succulent peas and 28 days dry peas. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/a per season for succulent peas or 0.188 lb ai/a for dry peas. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Do not feed forage or hay to livestock. Some formulations are OMRI-listed for organic use.

## Pea, green and dry—Looper

**Includes** alfalfa looper (*Autographa californica*)

### Pest description, crop damage and life history

See

Common Pests of Vegetable Crops

**Pest monitoring** Use a sweep net to sample for large larvae. Take a minimum of 100 sweeps divided into groups of 10 in different parts of the field and along the margins. Sequential sampling that involves fewer samples, and presence-or-absence sampling that does not involve counting, also may be used.

Pheromone traps can be used to monitor for the emergence of adult male alfalfa and cabbage looper moths.

### Management—biological control

Cabbage loopers have many natural enemies that may keep them below economic levels if they are not killed by insecticide treatments for other

pests. These include several important, naturally occurring parasites. A nuclear polyhedrosis virus disease is also important under certain circumstances.

If looper populations are increasing but below treatment thresholds, and you find a significant percentage of parasitized or disease-killed individuals, delay treatment decisions for a few days to see if these natural controls will bring populations down on their own. If treatment is necessary, *Bacillus thuringiensis* insecticide minimizes injury to natural enemies and is sometimes sufficient when looper pressure is relatively low.

#### Management—cultural control

Weed control can significantly affect looper management. Eliminate concentrations of lambsquarters, mustard, and other weeds that attract and host looper moths.

#### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- esfenvalerate
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin)—See product labels for rates. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Bt is less effective and acts more slowly during cool weather when larvae feed slowly. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- carbaryl (Sevin) at 1.5 lb ai/a. PHI 3 days for succulents, 21 days for dried, 14 days for forage, and 21 days for hay. REI 12 hr. Alfalfa looper (suppression). Observe plant-response precautions. Toxic in aquatic habitats. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- esfenvalerate (Asana) at 0.03 to 0.05 lb ai/a. PHI 3 days for green peas, 21 days for dry peas. REI 12 hr. Labeled for alfalfa looper on green peas only and for cabbage looper on dry peas only. Do not exceed 0.2 lb ai/a (dry peas) or 0.1 lb ai/a (green peas) per season. Do not feed or graze treated vines. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- fenpropathrin (Danitol) at 0.2 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- gamma-cyhalothrin (Proaxis) at 0.0075 to 0.015 lb ai/a. PHI 7 days edible podded and succulent shelled peas, and 21 days for dry shelled peas. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- lambda-cyhalothrin (Warrior) at 0.02 to 0.03 lb ai/a. PHI 7 days for succulent peas, 21 days for dry peas. REI 24 hr. Do not graze, or feed to livestock. Do not exceed 0.12 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- methomyl (Lannate) at 0.45 to 0.9 lb/a. PHI 1 day for harvest, 5 days for forage, 14 days for hay. REI 48 hr. Green peas only. Do not exceed six applications per crop or 2.7 lb ai/a per season.
- methoxyfenozide (Intrepid) at 0.06 to 0.12 lb ai/a early-season or 0.12 to 0.25 lb ai/a mid- to late-season. PHI 7 days. REI 4 hr. Do not exceed 1 lb ai/a per season. Retreatment interval 7 days.
- naled (Dibrom) at 0.94 lb ai/a. PHI 1 day. REI 48 hr. Processing peas only. Do not feed vines. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Radiant SC) at 0.0391 to 0.0781 lb ai/a. PHI 28 days for dry peas, 3 days for fresh peas. Retreatment interval 4 days. REI 4 hr. Do not exceed six applications or 0.94 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Follow resistance management procedures on the label. Cabbage looper only.
- spinosad (Success) at 0.06 to 0.09 lb ai/a. PHI 3 days for succulent peas, 28 days dry peas. REI 4 hr. Treat eggs at hatch and small larvae. Do not exceed 0.45 lb ai/a per season for green peas or 0.188 lb ai/a for dry peas. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Do not feed forage or hay to livestock. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.04 to 0.05 lb ai/a (Mustang) or 0.2 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas and 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Pea, green and dry—Pea leaf weevil

*Sitona lineata*

**Pest description and crop damage** Adults are grayish-brown, slender weevils about 0.19 inch long with a short snout. Wing covers are marked lengthwise by parallel striations. Larvae are small, C-shaped, legless, soft and fleshy, and up to 0.19 inch long. They are milky-white with a brown head. The pea leaf weevil can be confused easily with the sweet clover weevil. The pea leaf weevil has three light-color, inconspicuous stripes that

extend lengthwise down the thorax and often onto the wing covers. Sweet clover weevils do not have these stripes.

Adults chew half-circle notches out of leaf margins, and larvae feed on rhizobial root nodules. Seedlings are very susceptible to injury and may be killed if the growing tip is damaged. Damage also may occur later in the year by larvae feeding on the roots of plants, particularly on root nodules. However, older plants—six or more expanded leaves with growing tips intact—are much less likely to suffer significant injury. Host plants include peas, alfalfa, clover, faba beans, and vetch.

**Biology and life history** Adults overwinter under vegetation in old alfalfa and clover fields or in waste areas. Adult activity and egg laying begin in mid March on the coast and in mid April to early May inland. Eggs are scattered on the soil surface near plants. Eggs hatch in 16 to 18 days and larvae move into the soil to feed on root nodules. Larvae feed for 20 to 40 days, then pupate in the soil. Adults emerge in July and August, disperse to other legumes, and either feed or summer hibernate (aestivate) before overwintering. In coastal areas, there may be activity during mild weather in the fall and winter. There is one generation each year.

**Pest monitoring** Pea weevils thrive under cool, wet conditions and become less of a problem as the weather warms. Damage to pea plants is more severe when growing conditions are cool and wet. Check emerging pea plantings by examining plants and rolling over dirt clods where adults may be hiding. Sweeping can be used for sampling adjacent fields where sufficient foliage has developed. Cone traps with aggregation pheromone also can be used. Economic damage can occur at densities as low as three-tenths adult weevils per seedling plant. Consider 25% growing-point injury on seedling plants an action threshold.

#### **Management—cultural control**

Crop rotation and planting peas away from other legumes is useful. Irrigation and proper fertilization may help crops outgrow defoliation.

#### **Management—chemical control: HOME USE**

- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- carbaryl (Sevin) at 1.5 lb ai/a. PHI 3 days for succulents, 21 days for dried, 14 days for forage, 21 days for hay. REI 12 hr. Do not exceed 6 lb ai/a per season. Toxic in aquatic habitats. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- esfenvalerate (Asana) at 0.025 to 0.05 lb ai/a. PHI 3 days for green peas, 21 days for dry peas. REI 12 hr. Application timing is critical to control. Do not feed treated vines to livestock. Do not exceed 0.2 lb ai/a (dry peas) or 0.1 lb ai/a (green peas) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- phosmet (Imidan) at 0.70 to 0.93 lb ai/a. PHI 7 days for green peas or grazing, 10 days for cut hay. REI 5 days. Warning: Imidan residues can be highly hazardous to bees for up to 4 days. Do not use this material if blooming weeds are in the field edges or adjacent areas.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.035 to 0.05 lb ai/a (Mustang) or 0.017 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas, 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## **Pea, green and dry—Pea moth**

*Laspeyresia nigricana*

**Pest description and crop damage** The pea moth adult has a wingspan of about 0.5 inch, long antennae, and brownish gray wings with white and yellow spots in herringbone pattern. The larva is small, yellowish white, and about 0.5 inch when full grown. It has a light brown head and short, sparse hairs. The pupa is dark brown and about 0.31 inch long with rows of spines. Hosts include peas, vetch, clover, and lentil.

Larvae damage the crop by tunneling into pods and feeding on one or more seeds in the pod. Often up to six seeds are damaged, though only one or two severely. However, seeds perforations, the presence of caterpillars, and stains cause processors and the packing trade to reject consignments of attacked peas.

**Biology and life history** The pea moth overwinters as a caterpillar in a cocoon. Pupation begins in May in a slight cocoon just below the surface of the ground. Emergence and moth flight towards pea crops begins at the end of May, coinciding with the start of flowering, and continues until the end of July. The adult moth looks for sheltered places in dense vegetation to lay eggs. Egg laying occurs at intervals over 5 to 11 days after emergence. The female deposits 1 to 3 eggs on the stipules or the leaflets. Eggs hatch in 1 to 3 weeks, depending on the temperature. The emerging larvae go through a very short wandering stage (1 day) before penetrating a young pod. Larval development lasts 18 to 30 days. The larva then leaves the pod and migrates to the ground, where it spins a cocoon containing particles of soil, and hibernates. There is usually one generation per year.

**Pest monitoring** In England, pheromone traps are used to monitor pea moth problems. Wait 10 to 15 days from the beginning of sustained moth catches until application of insecticide, to allow egg laying and hatching to take place.

#### **Management—cultural control**

Tillage can destroy overwintering larvae. Disking the soil twice is often recommended. Destroy wild vetches and nearby weeds. Earlier crops may

escape serious attack.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- esfenvalerate
- gamma-cyhalothrin—Not for use on dry peas.
- imidacloprid
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

None registered.

## Pea, green and dry—Pea weevil

*Bruchus pisorum*

**Pest description and crop damage** The adult pea weevil is a chunky beetle about 0.19 inch long with a short, broad snout. It is brown flecked with white, black, and gray patches. The top of the abdomen is exposed behind the wing covers. The larva is C-shaped, up to 0.25 inch long, legless, brown-headed, and cream-color. Adults feed on pea pollen, and the female lays eggs on developing pea pods. The larva burrows directly through the pod, where it feeds and develops in the developing pea seed. While one larva develops in a single seed, nearly every pea may be infested when populations are high.

**Biology and life history** Adults overwinter with peas primarily in storage but also in the field. The pea weevil emerges about when peas are blooming, feeding on flowers (pollen and petal), leaves, or pods. The elongated yellow eggs are laid on the outside of the pod singly or in pairs. Although one to a dozen eggs are laid per pod, only one larva develops per pea. Hatching is in 1 to 3 weeks. The larva burrows through into the pea and matures in 5 to 6 weeks. Infested peas “heat,” aiding larval development. Pupation takes about 2 weeks, late in summer. Adults may leave the pea immediately or stay inside it all winter. There is only one generation per year.

**Pest monitoring** One weevil in 25 sweeps may result in 10% infested peas at harvest. Take samples along field margins, fence rows, and in the field. The most conservative approach is to apply appropriate insecticides at bloom prior to detecting adult pea weevils.

**Management—cultural control**

It is very important to destroy crop residues. Do not plant infested seed unless it is fumigated. Careful harvesting prevents shattering that can disperse weevils throughout fields. Destroy volunteer plants. Early planting and harvesting is also desirable.

**Management—chemical control: HOME USE**

- acetamiprid—Do not use on green peas.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- esfenvalerate
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

Insecticides must be applied soon after first blooms appear and before pods start to form. Additional applications may be needed to control migrating weevils.

- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.05 lb ai/a per season.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Succulents only. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- carbaryl (Sevin) at 1.5 lb ai/a. PHI 3 days for succulents, 21 days for dried, 14 days for forage, 21 days for hay. REI 12 hr. Do not exceed 6 lb ai/a per season. Toxic in aquatic habitats. Latex-based formulations such as Sevin XLR Plus are less hazardous to bees.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season. Do not feed vines or hay. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- esfenvalerate (Asana) at 0.025 to 0.05 lb ai/a. PHI 3 days for green peas, 21 days for dry peas. REI 12 hr. Do not exceed 0.2 lb ai/a (dry peas) or 0.1 lb ai/a (green peas) per season. Do not feed or graze treated vines. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

- malathion (numerous products) at 0.94 to 2.5 lb ai/a. PHI 3 days. Do not graze or feed to livestock. REI 12 hr.
- phosmet (Imidan) at 0.7 to 0.93 lb ai/a. PHI 7 days for green peas or grazing, 10 days for cut hay. REI 24 hr. Warning: Imidan residues can be highly hazardous to bees for up to 4 days. Do not use this material if blooming weeds are near field borders or adjacent areas.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.035 to 0.05 lb ai/a (Mustang) or 0.017 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas, 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Pea, green and dry—Seedcorn maggot

*Delia platura*

### Pest description and crop damage

See:

Common Pests of Vegetable Crops

### Biology and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Corn, sweet—Seedcorn maggot

### Management—chemical control: HOME USE

- bifenthrin
- gamma-cyhalothrin—Not for use on dry peas.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chlorpyrifos (Lorsban 30F) at 2.75 fl oz/cwt seed, as a slurry treatment. Commercial seed treatments only.
- thiamethoxam (Cruiser) at 0.05 lb ai/cwt seed. REI 12 hr.
- thiamethoxam + mefenoxam + fludioxnil (Cruiser Maxx) at 1.5 fl oz/100 (product) lb seed. REI 48 hr. Minimum plantback interval 120 days.

## Pea, green and dry—Thrips

Includes *Frankliniella* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Treatment is usually not necessary on seedlings, because most plants recover from thrips injury. Thrips are also beneficial at this time because of their role as mite predators.

### Management—biological control

Minute pirate bugs play a major role in controlling thrips populations.

### Management—cultural control

Thrips populations tend to build up on weeds. Cultivating nearby weedy areas before the crop emerges reduces the potential of a thrips problem when the weeds begin to dry out. Cultivating weedy areas after crop emergence increases thrips problems.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations OMRI-listed for organic use.
- carbaryl
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.

- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.085 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Succulent shelled peas only.
- bifenthrin (Capture, Sniper) at 0.033 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- borate complex (Prev-Am) apply as 0.8% solution to complete coverage. PHI 12 hr. REI 12 hr. OMRI-listed for organic use.
- fenprothrin (Danitol) at 0.2 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season. Dry pea only
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days for succulent peas, 21 days for dry peas. REI 24 hr. Do not graze or feed to livestock. Do not exceed 0.12 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Radiant SC) at 0.0391 to 0.0781 lb ai/a. PHI 28 days for dry peas, 3 days for fresh peas. Retreatment interval 4 days. Do not exceed six applications or 0.219 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Follow resistance management procedures on the label.
- spinosad (Success) at 0.071 to 0.094 lb ai/a. PHI 3 days for succulent peas; 28 days for dry peas. REI 4 hr. Do not exceed 0.45 lb ai/a (succulent peas) or 0.188 lb ai/a (dried peas) per season. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.04 to 0.05 lb ai/a (Mustang) or 0.2 to 0.25 lb ai/a (Mustang Max). PHI 1 day for succulent peas, 21 days for dry peas. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a (Mustang) or 0.15 lb ai/a (Mustang Max) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

## Pea, green and dry—Wireworm

*Limonius* spp.

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—biological, cultural, tactical**

*See:*

Potato, Irish—Wireworm

**Management—chemical control: HOME USE**

- bifenthrin (often as a mix with zeta-cypermethrin)
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- diazinon at 3 to 4 lb ai/a broadcast before planting and incorporate into top 4 to 8 inches of soil. REI 3 days. Succulent peas only.
- imidacloprid (Gaucho 480F) at 0.063 to 0.125 lb ai/cwt seed prior to planting.
- thiamethoxam (Cruiser) at 0.05 lb ai/cwt seed. REI 12 hr.
- thiamethoxam + mefenoxam + fludioxnil (Cruiser Maxx) at 1.5 fl oz (product) /100 lb seed. REI 48 hr. Minimum plantback interval 120 days.

## Pepper—Aphid

**Includes** green peach aphid (*Myzus persicae*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—biological control**

Many parasites and predators attack aphid. Monitor the proportion of aphid mummies to unparasitized adults and the number of predators such as lady beetles. If the biocontrol agents appear to be gaining control, avoid sprays which would disrupt this system. Most products available for aphid control are highly disruptive of natural enemy populations.

**Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil.—Some formulations are OMRI-listed for organic use.
- imidacloprid
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90 WDG) at 0.5 to 1 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 2 lb ai/a bell type or 1 lb ai/a on bell peppers per season. Retreatment interval 7 days.
- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Limit 4 treatments.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeated applications are necessary. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season. bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days. Do not graze treated areas or cut for feed.
- borate complex (Prev-Am Ultra) apply as 0.8% solution to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- dimethoate (Dimethoate 4E) at 0.25 to 0.33 lb ai/a. PHI 0 days when mechanically harvested. REI 48 hr. Retreatment interval 7 days. Do not exceed 1.65 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar and 21 days soil. REI 12 hr. Do not exceed per season 0.266 lb ai/a foliar or 0.532 lb ai/a for soil.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200 SL) at 0.091 to 0.156 lb ai/a foliar; 0.274 lb ai/a soil. PHI 1 day foliar; 45 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season. Limit 3 treatments per season.
- imidacloprid (Admire Pro) at 0.25 to 0.5 lb ai/a soil, 0.047 to 0.079 lb ai/a foliar, 0.016 lb ai/10,000 greenhouse plants. Retreatment interval 5 days. PHI 21 days soil; 0 days foliar. REI 12 hr. Do not exceed 0.5 lb ai/a soil per application or 0.24 lb ai/a foliar per season. Do not exceed 0.0156 lb ai/10,000 plants in planthouse.
- imidacloprid (Provado, Prey) at 0.048 to 0.078 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.5 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Limit 2 treatments per year.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 3 days. REI 48 hr. Do not exceed 4.5 lb ai/a per season.
- naled (Dibrom 8E) at 0.9 to 1.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 5.4 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 6 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not

exceed 0.14 lb ai/a per year. Apply by ground equipment.

- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a of thiamethoxam or 0.2 lb ai/a of chlorantraniliprole per season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Pepper—Armyworm, cutworm, and looper

### Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agrotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)  
Alfalfa looper (*Autographa californica*)  
Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* ssp. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- permethrin
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acephate (Acephate 90 WDG) at 0.05 to 1 lb ai/a. PHI 7 days. REI 24 hr. Bell pepper only. Do not exceed 2 lb ai/a per season. Retreatment interval 7 days.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. A spreader-sticker improves control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.017 to 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12

lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.

- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil application. Do not exceed 0.1 lb ai/a per season as an at plant application. Cutworms only.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 9 days. REI 7 days. Do not exceed 0.2 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.04 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days. Do not graze treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- borate complex (Prev-Am Ultra)—apply at 0.4% solution to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F, Sevin 5 Bait) at 2 lb ai/a bait, 1 to 2 lb ai/a foliar. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season. Limit 3 bait treatments or 7 foliar treatments per year.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at plant; drip; foliar. PHI 1 day. REI 4 hr. Retreatment interval 5 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.6 lb ai/a per season. Greenhouse only.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cryolite (Kryocide) at 7.7 to 11.5 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.033 to 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.168 lb ai/a per season.
- diflubenzuron (Dimilin 2L) at 0.063 to 0.125 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 6 oz ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a per season.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- GS-omega/kappa-Hctx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Use of a wetting agent is recommended. Allow at least 5 days between applications. Do not exceed 0.26 lb ai/a per season. Limit 4 treatments.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not graze or feed to livestock. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- methomyl (Lannate SP) at 0.23 to 0.9 lb ai/a. PHI 3 days. REI 48 hr. Do not exceed 4.5 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early season and 0.12 to 0.25 lb ai/a mid to late season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Permethrin, Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/a. PHI 3 days. REI 12 hr. Bell pepper only. Do not exceed 0.8 lb ai/a foliar or 1.6 lb ai/a bait per season. Retreatment interval 5 days.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling fruiting vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.046 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Entrust SC is OMRI-listed for organic use.
- *Spodoptera frugiperda* (Fawligen) at 1.0 to 2.4 fl oz/a. PHI 0 day. REI 4 hr. Beet armyworm only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-season, or 0.12 to 0.25 lb ai/a mid- to late-season. PHI 7 days. REI 4 hr. Do not exceed 0.25 lb ai/a per application or 1 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary for heavy infestations. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a of thiamethoxam or 0.2 lb ai/a of chlorantraniliprole per season.

- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Pepper—Flea beetle

**Includes** western potato flea beetle (*Epitrix subcrinita*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—cultural control

Weed control in adjacent areas will discourage flea beetles.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- imidacloprid
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Allow at least 7 days between applications.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil application. Do not exceed 0.1 lb ai/a per season as an at plant application.
- bifenthrin/imidacloprid (Brigadier) at 0.04 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days. Do not graze treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyfluthrin (Tombstone) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar and 21 days for soil. REI 12 hr. Do not exceed per season 0.266 lb ai/a foliar or 0.532 lb ai/a for soil.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.35 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.5 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per soil application.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Do not graze or feed to livestock. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed

0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.

- naled (Dibrom 8E) at 0.9 to 1.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 5.4 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/a. PHI 3 days. Bell pepper only. Do not exceed 0.8 lb ai/a per season. Retreatment interval 5 days.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a of thiamethoxam or 0.2 lb ai/a of chlorantraniliprole per season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Pepper—Garden symphylan

*Scutigerella immaculata*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of the symphylan's ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. We do not have an action threshold for symphylans in peppers in Oregon. In general, preplant field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

### Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

### Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied.

### Management—chemical control: HOME USE

- bifenthrin
- cyfluthrin
- pyrethrins

### Management—chemical control: COMMERCIAL USE

- beta-cyfluthrin (Baythroid XL) at 0.022 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.

## Pepper—Spider mite

*Tetranychus* spp.

### Pest description and crop damage

*See:*

Common Pests of Vegetable Crops

### Biology and life history

*See:*

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (such as clove, garlic or rosemary)—These have some efficacy against spider mites. Some formulations are OM-

RI-listed for organic use.

- sulfur (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season.
- acequinocyl (Kanemite 15SC) at 0.3 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per season.
- bifenazate (Acramite 50WS) at 0.375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr. One treatment per season.
- bifenthrin/avermectin (Athena) at 0.048 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.6 lb ai/a per season. Greenhouse only.
- etoxazole (Zeal) at 0.09 to 0.135 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.135 lb ai/a per season.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- fenpyroximate (Miteus) at 1.05 lb ai/a. PHI 1 day. REI Do not exceed 2.1 lb ai/a per season. Limit 2 applications. Retreatment interval 14 days.
- hexythiazox (Onager) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 12 hr. One treatment.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- naled (Dibrom 8E) at 0.9 to 1.9 lb ai/a. PHI 1 day. REI 48 hr, or 72 hr at rates above 1 lb ai/a. Do not exceed 5.4 lb ai/a per season.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- spiromesifen (Oberon 2EC) at 0.11 to 0.13 lb ai/a PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.

## **Pepper—Whitefly**

### **Includes**

Greenhouse whitefly (*Trialeurodes vaporariorum*)

Silverleaf whitefly (*Bemesia argentifolii*)

Sweetpotato whitefly (*Bemesia tabaci*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

### **Management—cultural control**

Inspect new plants before purchase: infestations often are introduced. Encourage natural enemies such as ladybird beetles, spiders, and parasitic wasps. Avoid use of broad-spectrum insecticides which reduce populations of these.

### **Management—chemical control: HOME USE**

For best results, direct spray toward undersides of leaves. Read label application instructions carefully.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season. Limit 4 treatments.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Allow at least 7 days between applications.
- bifenthrin/imidacloprid (Brigadier) at 0.04 to 0.15 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.2 lb ai/a imidacloprid and 0.2 lb ai/a bifenthrin. Retreatment interval 7 days. Do not graze treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days in field; 7 days in greenhouse. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.11 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar and 21 days soil. REI 12 hr. Do not exceed per season 0.266 lb ai/a foliar or 0.536 lb ai/a for soil.
- flupyradifurone (Sivanto 200 SL) at 0.14 to 0.18 lb ai/a foliar; 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar; 45 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.5 lb ai/a soil, 0.047 to 0.079 lb ai/a foliar, 0.016 lb ai/10,000 greenhouse plants. Retreatment interval 5 days. PHI 21 days soil; 0 days foliar. REI 12 hr. Do not exceed 0.5 lb ai/a soil per application or 0.24 lb ai/a foliar per season. Do not exceed 0.0156 lb ai/10,000 plants in planthouse.
- imidacloprid (Provado, Prey) at 0.048 to 0.078 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- *Metarhizium anisopliae* (Met52 EC) at 40 to 80 fl oz/100 gal as drench or 8 to 64 fl oz/a foliar. PHI 0. REI 4 hr.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- pyriproxyfen (Knack) at 0.054 to 0.067 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.109 lb ai/a per season. Retreatment interval 14 days.
- spiromesifen (Oberon 2EC) at 0.11 to 0.13 lb ai/a PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.066 to 0.07 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.047 to 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a of thiamethoxam or 0.2 lb ai/a of chlorantraniliprole per season.

## Pepper—Wireworm

*Limonius* spp.

**Pest description and crop damage** Wireworms are the soil-dwelling larvae of click beetles. Adult click beetles are slender, tan to nearly black, and about 0.37 inch long. Larvae are hard, segmented, 0.37 to 0.5 inch long and dark yellow or brown. They resemble mealworms. Wireworms injure seedlings by feeding on roots, tubers, or bulbs, or boring into stems. Damage is more common in spring planted crops where the soil has a high organic content, such as fields that recently have been in or adjacent to alfalfa, pasture, or uncontrolled weeds. Wireworms do not significantly damage older plants.

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin

- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a at planting. PHI 7 days. REI 12 hr. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per season.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 9 days. REI 7 days. Do not exceed 0.2 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a soil application. Do not exceed 0.1 lb ai/a per season as an at plant application.

## Potato, Irish

See:

Irish Potato Pests

## Potato, sweet—Aphid

**Includes**

Green peach aphid (*Myzus persicae*)

Melon aphid (*Aphis gossypii*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description and crop damage** The green peach aphid is slender, dark green to yellow, and has no waxy bloom. Infestations may result in wilting. The melon aphid is variable in color but is often light green mottled with dark green. Unlike other aphids, it is able to tolerate hot weather. The potato aphid has both a pink and green form. It is a larger aphid. High potato aphid populations can distort leaves and stems, stunt plants, and cause necrotic spots on leaves. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit.

Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases such as alfalfa mosaic, tomato yellow top, and zucchini yellow mosaic (a large number of viruses are spread by aphids). Infestations frequently are localized; heavily infested leaves curl down.

**Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

**Management—chemical control: HOME USE**

Apply to both tops and undersides of leaves.

- acetamiprid
- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.047 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 0.3 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.132 lb ai/a beta-cyfluthrin or 0.263 lb ai/a imidacloprid per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.12 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.13 lb ai/a imidacloprid and 0.5 lb ai/a bifenthrin per season. Retreatment interval 7 days. Do not graze treated areas or cut for feed.

- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Limit 2 treatments.
- clothianidin (Belay) at 0.033 to 0.05 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per year.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.263 lb ai/a per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per year.
- dinotefuran (Scorpion 35SG) at 0.045 to 0.068 lb ai/a foliar; 0.293 to 0.338 lb ai/a soil. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.338 lb ai/a per year.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.06 lb ai/a per season. Retreatment interval 7 days.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a at planting and 0.043 lb ai/a foliar. PHI 7 days foliar; for soil application 3 days (leaves) and 125 days (corms). REI 12 hr. Do not exceed 0.38 lb soil ai/a foliar or 0.13 foliar per season. Retreatment interval 5 days.
- imidacloprid (Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.72 lb ai/a. PHI 14 days. REI 24 hr. Minimum interval between applications 7 days. Do not exceed 0.172 lb ai/a of thiamethoxam or 0.36 lb ai/a of lambda-cyhalothrin per season.
- pymetrozine (Fulfill) at 0.086 to 0.172 lb ai/a. PHI 14 days. REI 12 hr. Two applications may be needed for persistent populations. Aphids stop feeding soon after treatment but may remain on plants 4 to 10 days, until they die. Do not exceed 0.344 lb ai/a per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 14 days. REI 12 hr. Limit 2 treatments. Retreatment interval 14 days. Do not exceed 0.094 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Transform WG) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 14 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.047 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.094 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.125 lb ai/a soil applied. REI 12 hr. Do not exceed 0.125 lb ai/a per season. See label for recommended in-row application instructions.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 14 day. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments per year. Do not exceed 0.42 lb ai/a per year.

## Potato, sweet—Spider mite

*Tetranychus* spp.

**Pest description and crop damage** Several species of spider mite are common in the Pacific Northwest. Frequently, infestations include a mixture of spider mite species. Adult mites are about 0.06 inch long, have four pair of legs, are greenish to pink or cream color, and have various-size black spots on the body. Under warm conditions, spider mites move rapidly within the colony area. Damaged leaves become somewhat stippled on the upper surface and may turn brown or bronze with heavy damage. The undersurface of leaves may have a grayish cast due to webbing. Wilting, leaf deformity, tissue death, and abscission all may take place.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (such as clove or rosemary)—These have some efficacy against spider mites. Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.019 lb ai/a per year. Retreatment interval 7 days.
- bifenazate (Acramite 4SC) at 0.5 to 0.75 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Limit 2 applications.
- fenpyroximate (Miteus) at 0.11 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.21 lb ai/a per season. Limit 2 treatments.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr

## Potato, sweet—Wireworm

**Includes** *Ctenicera* spp.

**Pest description and crop damage** Wireworms are the soil-dwelling larvae of click beetles. Adult click beetles are slender, tan to nearly black, and about 0.37 inch long. Larvae are hard, segmented, 0.37 to 0.5 inch long and dark yellow or brown. They resemble mealworms. Wireworms injure seedlings by feeding on roots, tubers, or bulbs, or boring into stems. Damage is more common in spring planted crops where the soil has a high organic content, such as fields that recently have been in or adjacent to alfalfa, pasture, or uncontrolled weeds. Wireworms do not significantly damage older plants.

### **Management—biological, cultural, tactical**

*See:*

Potato, Irish—Wireworm

### **Management—chemical control: HOME USE**

- bifenthrin (as a mix with zeta-cypermethrin),
- cyfluthrin
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

- bifenthrin (Brigade 2EC) at 0.15 to 0.3 lb ai/a at planting or 0.05 to 0.15 lb ai/a at lay-by or 0.033 to 0.1 lb ai/a foliar. PHI 21 days. REI 12 hr. See label instructions. Do not exceed 0.5 lb ai/a per year.
- chlorpyrifos (Lorsban Advanced) at 1.88 lb ai/a. PHI 125 days. REI 24 hr. Preplant broadcast, incorporated 4 to 6 inches. One application only. **RESTRICTED USE IN OREGON.**
- ethoprop (Mocap 15G) at 0.24 to 0.315 lb ai/1,000 row ft (incorporate 2 to 4 inches after treatment). REI 48 hr or 72 hr if rainfall is less than 25 inches.
- phosmet (Imidan) at 1 lb ai/a foliar or plantbed treatment. PHI 7 days. REI 4 days seedbed and 5 days foliar. Do not exceed 4.67 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.125 lb ai/a. REI 12 hr. Spray directly on the seed pieces in the furrow. Do not exceed 0.125 lb ai/a per season. See label for recommended application instructions.

## Pumpkin and squash—Aphid

### **Includes**

Bean aphid (*Aphis fabae*)

Melon aphid (*Aphis gossypii*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description and crop damage** The bean aphid is dark olive green to black with light-color legs. It is usually more of an early-year pest. The melon aphid is variable in color but is often light green mottled with dark green. Unlike other aphids, it is able to tolerate hot weather. The potato aphid has both a pink and green form. It is a larger aphid. High potato aphid populations can distort leaves and stems, stunt plants, and cause necrotic spots on leaves. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit.

Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases (a large number of viruses are spread by aphids). Infestations frequently are localized; heavily infested leaves curl down.

### **Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—When applied as a spray to foliage and stems, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.

- malathion—Do not use on wet or damp foliage.
- permethrin
- plant-derived essential oils (rosemary, peppermint, thyme etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at time of application.

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) 0.047 to 0.075 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—PHI 0 days. REI 4 hr. See label for rates. Acts slowly; apply early. Thorough coverage and repeated applications are necessary.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar; 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a soil. PHI 1 day (foliar), 21 days (soil). REI 12 hr. Do not exceed per season 0.266 lb ai/a foliar or 0.532 lb ai/a soil. Retreatment interval 7 days.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a foliar; 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar; 21 days soil. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil or 0.016 lb ai/10,000 plants for planthouse. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per soil application. Do not exceed 0.0156 lb ai/10,000 plants. Limit 1 planthouse treatment.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a rates. PHI 0 days. REI 12 hr.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8) at 1 lb ai/a pumpkin and winter squash; 1.75 lb ai/a summer squash. PHI 1 day. REI 12 hr for pumpkin and winter squash and 24 hr for summer squash. Retreatment interval 7 days. Limit 2 treatments pumpkins and 3 treatments squash per year.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a foliar. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Do not exceed 4 lb ai/a per season.
- permethrin (Permethrin) 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 1.2 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Two applications may be needed for persistent populations. Aphids stop feeding soon after treatment but may remain on plants 4 to 10 days, until they die. Do not exceed 0.172 lb ai/a per season.
- pyriproxyfen (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.14 lb ai/a per year. Apply by ground equipment.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.16 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 10 days. Do not exceed 0.48 lb ai/a tebuconazole and 0.18 lb ai/a lambda cyhalothrin.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season. See label for recommended in-row application instructions.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.196 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Pumpkin and squash—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

**Pest description and crop damage** The western spotted cucumber beetle is yellowish green, 0.25 inch long, and has 11 black spots on its wing covers. Mature larvae are white except for the head and last abdominal segment, which are brown. They are about 0.62 inch long. A close relative, the western striped cucumber beetle, is yellowish and has three black lines down its back. The larvae live in the soil, where they feed on roots. Adults are foliage and flower feeders. Cucumber beetle adults eat small holes in the leaves and flowers of many crops. Larvae feed on roots and bore into the base of stems.

**Biology and life history** Cucumber beetles overwinter as fertilized adults and are active beginning in early spring. Adults lay eggs at the base of plants. Eggs hatch in 7 to 10 days, and larvae feed in roots for about 3 weeks before pupating in the soil. Adults emerge in 2 weeks and begin feeding on pollen. As soon as they hatch, larvae begin to feed on plant roots. They complete their development in the soil. It takes 30 to 60 days to complete a life cycle. There are two generations a year.

**Pest monitoring** Specific treatment thresholds have not been established for these foliage feeders. Late year infestations are insignificant. If damaging numbers are encountered mid year, excessive foliage loss may reduce crop production. To prevent cucumber beetle damage to seedlings, Virginia recommendation is to treat at one beetle per 10 row ft.

### Management—cultural control

Commercial row crop covers provide good protection from cucumber beetles, and in addition provide late frost protection and help in moisture retention. Sometimes, the timing of a crop planting can be delayed until after beetles have dispersed and deposited most of their eggs. Delaying planting until warmer weather also gives crops a greater chance of outgrowing beetle injury. Trap crops sometimes can be used to draw beetles away from the main crop. Trap cropping is an unproven control method in Oregon.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at time of application.

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) 0.047 to 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.088 lb ai/a per season.
- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications bloom. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- carbaryl (Sevin 4F) at 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 6 treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar; 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 7

days. Do not exceed 0.2 lb ai/a per season.

- cyfluthrin (Tombstone) at 0.038 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.175 lb ai/a per season.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 days foliar, or 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.09 lb ai/a per season.
- GS-omega/kappa-Hctx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per application.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Fyfanon 8) at 1 lb ai/a for pumpkins and winter squash and 1.75 lb ai/a for summer squash. PHI 1 day. REI 12 hr for pumpkins and winter squash; 24 hr for summer squash. Limit 2 treatments pumpkins and 3 treatments squash per year
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day at 0.45 lb ai/a and 3 days above 0.45 lb ai/a. REI 48 hr. Do not exceed 5.4 lb ai/a per season. Summer squash only.
- naled (Dibrom 8E) at 0.94 to 1.9 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 5.6 lb ai/a per season. Summer squash only.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Permethrin) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 1.2 lb ai/a per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 10 days. Do not exceed 0.48 lb ai/a tebuconazole and 0.18 lb ai/a lambda cyhalothrin.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Pumpkin and squash—Nitidulid beetle

Several species

**Pest description and crop damage** Nitidulid beetles are shiny black beetles about 0.19 inch long. The pollen-seeking adults damage flowers. Browned flowers are unattractive to pollinators.

**Management—chemical control: HOME USE**

- None registered.

**Management—chemical control: COMMERCIAL USE**

Effective chemicals previously used for control are no longer registered for use.

## Pumpkin and squash—Seedcorn maggot

*Delia platura*

**Pest description and crop damage** The seedcorn maggot adult is a slender, light gray fly about 0.19 inch long. It looks much like a small housefly. The whitish eggs have slightly raised ridges running the length and width of the eggs forming tiny rectangles. Larvae are about 0.25 inch long, white to whitish yellow, cylindrical, and tapered, with the smaller end in front. Pupae are small brown capsules. The seedcorn maggot is abundant during or following a wet cycle, primarily in spring, and is most common in fields containing a high amount of residue from a previous crop or where manure has been spread. Seedcorn maggots burrow into seeds and developing embryos in the ground, damaging and destroying seeds and creating sites for rot. They may spread bacterial soft rot.

**Management—biological, cultural, tactical**

*See:*

Corn, sweet—Seedcorn maggot

**Management—chemical control: HOME USE**

- bifenthrin (sometimes as a mix with zeta-cypermethrin)
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

*Seed treatment*

- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant. REI 12 hr. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per

season.

- bifenthrin (Brigade 2WSB) at 0.05 to 0.1 lb ai/a in-furrow with seed or transplant. REI 12 hr. Do not exceed 0.3 lb ai/a per year.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 7 days. Do not exceed 0.3 lb ai/a per season. Retreatment interval 7 days.
- chlorpyrifos (Lorsban 50W) at 1 oz ai/cwt seed. Pumpkin only. **RESTRICTED USE IN OREGON.**

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Pumpkin and squash—Slug

### Includes

*Arion* spp.

Black greenhouse slug (*Milax gagates*)

Gray field slug (*Derocerus reticulatum*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Not registered for use on pumpkin. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- Sodium ferric EDTA

### Management—chemical control: COMMERCIAL USE

- iron phosphate baits at 0.24 to 0.44 lb ai/a. PHI 0 days. REI: no restrictions.
- iron phosphate/spinosad at 0.01 to 0.03 lb ai/a. PHI 3 days. REI 4 hr.
- metaldehyde baits—Do not contaminate edible plant parts. Use as needed but not more than once per week.

## Pumpkin and squash—Spider mite

*Tetranychus* spp.

**Pest description and crop damage** Several species of spider mite are common in the Pacific Northwest. Frequently, infestations include a mixture of spider mite species.

Adult mites are about 0.06 inch long, have four pair of legs, are greenish to pink or cream color and have various-size black spots on the body. Under warm conditions, spider mites move rapidly within the colony area. Damaged leaves become somewhat stippled on the upper surface and may turn brown or bronze with heavy damage. The undersurface of leaves may have a grayish cast due to webbing. Wilting, leaf deformity, tissue death, and abscission all may take place.

### Management—biological control

Spider mite populations are held down in cool conditions early in the season by various predators such as pirate and big-eyed bugs. Predator mites are effective predators of spider mites and are available.

### Management—cultural control

Avoid early season applications of insecticides, which will reduce populations of beneficial insects. Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. Excessive nitrogen fertilization may cause population buildup.

*Home gardeners:* Mites can be hosed from plants with a strong stream of water.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.

- insecticidal soap—Apply control measures when mites first appear and repeat application as necessary. Complete coverage, especially under leaves, is essential. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (such as clove or rosemary)—These have some efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- sulfur (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at time of application.

#### **Management—chemical control: COMMERCIAL USE**

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Do not make more than two sequential applications. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season.
- acequinocyl (Shuttle O) at 0.3 lb ai/a. PHI 1 day. REI 12 hr. Limit 2 treatments. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per year.
- bifenthrin/avermectin (Athena) at 0.092 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenazate (Acramite 50W) at 0.375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr. One treatment per season only.
- bifenthrin (Brigade WSB) 0.08 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.
- etoxazole (Zeal) at 0.09 to 0.135 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 1 treatments per season.
- fenpropathrin (Danitol 2.4EC) at 0.2 to 0.3 lb ai/a. PHI 7 days. REI 24 hr. Do not exceed 0.8 lb ai/a per season.
- insecticidal soap (M-Pede) at 2% solution. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 0.03 lb ai/a (suppression only). PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- malathion (Fyfanon 8) at 1 lb ai/a pumpkin and winter squash; 1.75 lb ai/a summer squash. PHI 1 day. REI 12 hr for pumpkins and winter squash and 24 hr for summer squash. Retreatment interval 7 days. Limit 2 treatments pumpkins and 3 treatments squash per year
- naled (Dibrom 8E) at 0.94 to 1.9 lb ai/a. PHI 1 day. REI 48 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 5.6 lb ai/a per season. Summer squash only.
- propylene glycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- 

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## **Pumpkin and squash—Squash bug**

*Anasa tristis*

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest description and crop damage** The adult squash bug is flat-backed, brownish black, and measures about 0.62 inch long. Older nymphs are grayish white with black legs and antennae. Nymphs range from 0.19 to 0.5 inch long. Squash bugs feed primarily on squash and pumpkin. Adults and nymphs suck plant sap from the leaves and stems, causing wilting and death. Damage tends to be localized.

**Biology and life history** Squash bugs overwinter in protected places as unmated adults. They appear rather slowly in the spring. Adults mate and begin laying clusters of eggs about the time the squash vines begin to spread. Eggs are laid in clusters of a dozen or more on the leaves. They hatch in about 10 days into nymphs. Nymphs go through five molts before becoming adults in 4 to 6 weeks. There is only one generation per year.

### **Management—cultural control**

Early plantings are more susceptible to damage. Squash bugs tend to aggregate in sheltered locations, such as under mulches and in weeds. Clean cultivation is advised. Removal of crop debris in a timely manner is important.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin

**Note:** Pesticides can injure cucurbits. Be sure foliage is dry at the time of application.

**Management—chemical control: COMMERCIAL USE**

Apply dust around base of the plant. Avoid dusting foliage if possible.

- acetamiprid (Assail 30SG) 0.1 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 5 applications or 0.5 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.0175 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Do not apply more than twice after bloom. Allow at least 7 days between applications.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per season.
- carbaryl (Sevin 4F) at 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 6 treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year. Suppression.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 days foliar, or 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a for soil per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per year.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Permethrin) at 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 1.2 lb ai/a per season.
- tebuconazole/lambda cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 10 days. Do not exceed 0.48 lb ai/a tebuconazole and 0.18 lb ai/a lambda cyhalothrin.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per year.

**Note:** Pesticides may injure cucurbits. The possibility of injury is less when foliage is dry at time of application.

## Pumpkin and squash—Wireworm

*Limoniusspp.*

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—biological, cultural, tactical**

*See:*

Potato, Irish—Wireworm

**Management—chemical control: HOME USE**

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- bifenthrin (Brigade WSB) at 0.05 to 0.1 lb ai/a in furrow with seed or transplant. Refer to label. REI 12 hr.
- bifenthrin/IBA (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 3 days. REI 7 days. Do not exceed 0.3 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant. REI 12 hr. Do not exceed 0.056 lb ai/a avermectin or 0.3 lb ai/a bifenthrin per season.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre, soil application. REI 4 hr. OMRI-listed for organic use.
- chloropicrin (Telone)—Preplant.
- chlorpyrifos (Lorsban 50W) at 1 oz ai/cwt seed. Pumpkin only. **RESTRICTED USE IN OREGON.**

# Radish—Aphid

## Includes

Cabbage aphid (*Brevicoryne brassicae*)

Green peach aphid (*Myzus persicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

## Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

## Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not entering a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

## Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen.

## Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

## Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant-derived essential oils (rosemary, peppermint, thyme etc.). Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use..
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.022 lb ai/a beta-cyfluthrin or 0.044 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.44 lb ai/a per season. Oriental radish (Daikon) only.

- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.074 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.03 lb ai/a cyfluthrin or 0.04 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a, or 0.011 to 0.027 lb ai/1,000 row ft. soil; 0.044 lb ai/a foliar . Do not exceed 0.13 lb ai/a foliar or 0.38 lb ai/a per season. PHI 7 days foliar; 21 days soil. REI 12 hr.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. One application per season. Do not exceed 0.044 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a rates. PHI 0 days. REI 12 hr.
- malathion (Fyfanon 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments.
- sulfoxaflor (Transform WG) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 24 hr. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.063 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.1 lb ai/a soil treatment. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.063 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Retreatment interval 7 days.

## Radish—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)  
 Bertha armyworm (*Mamestra configurata*)  
 Western yellowstriped armyworm (*Spodoptera praefica*)  
 Black cutworm (*Agrotis ipsilon*)  
 Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Armyworms

**Pest monitoring** The bertha armyworm is considered a “climbing cutworm” because it spends little time near the ground. It can be easy to miss while scouting, because eggs and young instars tend to be clustered, but later in the year disperse actively. Larvae also tend to drop quickly from plants when disturbed, avoiding detection. Populations can explode due to an influx of overlapping generations of migrating moths along with overwintering populations.

Pheromone traps are useful for determining when major flights occur, but not for predicting damage. A 5-minute timed search is useful in determining the need for treatment. On average, if one or more larvae or egg masses are found in 5 minutes, treatments may be justified.

In those rare instances when control measures are required, the beet armyworm is more difficult to control than the western yellowstriped armyworm. Insecticide applications are most effective if applied against small larvae.

### Management—biological control

Common natural enemies of armyworms include several braconid and ichneumonid wasps; many general predators including assassin bugs, damsel bugs, and spiders; and a nuclear polyhedrosis virus, reported to have brought about excellent late year control in Canada. None of these natural enemies can be counted upon to achieve adequate control in any given year.

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

### Cutworms

**Pest monitoring** Pheromone traps can be used to monitor for cutworms in conjunction with field scouting. Moth counts in excess of two black cutworm moths per trap per day indicate significant egg laying pressure. Intensify field scouting.

If the cutworm population is reducing the plant stand, treat during the seedling stage. Frequently, the damage is most serious at the edges of a field, but stand loss can occur in a spotty pattern throughout the field.

Usually, it is necessary to dig in the soil to find black cutworm larvae and to determine the extent of the infestation and the size of the cutworms involved. Larvae normally hide under debris on the soil surface during the day, but are active, voracious feeders at night.

Since extensive damage may occur in a short period of time, inspect plant beds and newly set plants frequently. In North Carolina, an economic threshold of 5% injured plants has been established for cutworms infesting newly set or young plants (within 3 weeks after transplanting). In Ontario, Canada, the guideline for black cutworm on many seedling vegetables is also 5% plants infested.

#### **Management—biological control**

Cutworms are attacked by a number of predators, parasites, and diseases. Many of these natural control agents are not effective on pale western and black cutworms because of their subterranean nature. It is not known if any of these natural enemies can control cutworm populations, but their presence should be noted.

#### **Management—cultural control**

Cutworms are most injurious in fields with high plant residue. Historically, cutworms are a problem in early, spring-seeded seedling fields. Tillage prior to seeding reduces cutworm damage. A thorough harrowing between rows may provide some control when cutworms are feeding actively in established fields.

#### **Management—chemical control: HOME USE**

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (Btk)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (rosemary, peppermint, etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.11 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.022 lb ai/a beta-cyfluthrin or 0.044 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.44 lb ai/a per season. Oriental radish (Daikon) only.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 6 lb ai/a per season. Limit 6 treatments per season.
- carbaryl (Sevin 5 Bait) at 2 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre, soil application. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 4 applications per crop or 0.2 lb ai/a per crop.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.22 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.074 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.03 lb ai/a cyfluthrin or 0.04 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/a broadcast before planting and incorporate into the soil. REI 3 days.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season.

- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.5 lb ai/a per year.
- spinetoram (Radiant SC) at 0.047 to 0.0625 lb ai/a PHI 3 days. Retreatment interval 4 days. Do not exceed 3 applications or 0.188 lb ai/a per season. Limit 3 treatments.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.28 lb ai/a per season. Limit 3 treatments. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

**Note:** Using diazinon as recommended for cabbage maggot control also helps control cutworms.

## Radish—Cabbage maggot

*Delia brassicae*

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate.

If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments would be of little value.

Sticky traps and sweep nets also can be used to monitor the adult fly.

### Management—biological control

Rove beetles prey on maggot eggs and young larvae. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp *Trybliographa rapae* lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

### Management—cultural control

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury when a set of drag chains is attached behind the planter to eliminate the moisture gradient in the seedrow. It is believed that adult flies can locate the seed row for egg-laying by honing in on the higher moisture levels created when the soil is overturned for planting.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops, unless sufficient time has passed for the residue to dry or decompose completely.

### Management—chemical control: HOME USE

- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre, soil application. REI 4 hr. OMRI-listed for organic use.
- chlorpyrifos (Lorsban 15G) at 0.03 lb ai/1,000 row ft. REI 24 hr. Apply as an in-furrow drench at planting with at least 40 gal/a total spray. Do not exceed 2.75 lb ai/a or one application per season. **RESTRICTED USE IN OREGON.**
- cyantraniliprole (Exirel, Verimark) at 0.13 to 0.176 lb ai/a at planting. REI 4 hr. Do not exceed 0.4 lb ai/a per year.

## Radish—Diamondback moth

*Plutella xylostella*

### Pest description, crop damage, biology and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked under.

### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, take into account the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap (as a mix with spinosad)—May require several applications. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 7 days. REI 12 hr. Washington and Oregon only.
- zeta-cypermethrin (Mustang) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year

**Radish—Flea beetle**

**Including** cabbage flea beetle (*Phyllotreta cruciferae*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours.

Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 feet of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

**Management—cultural control**

Reduce weed hosts. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high value crops. Flea beetles can be vacuumed off foliage, but this practice must be repeated frequently. Reinvasion of plants can be rapid.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.11 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed

0.022 lb ai/a beta-cyfluthrin or 0.044 lb ai/a imidacloprid per season.

- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.44 lb ai/a per season. Oriental radish (Daikon) only.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 6 lb ai/a per season. Retreatment interval 7 days.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.22 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.074 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.03 lb ai/a cyfluthrin or 0.04 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.1 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a or 0.011 to 0.027 lb ai/1,000 row ft soil; 0.044 lb ai/a foliar. Do not exceed 0.13 lb ai/a foliar or 0.38 lb ai/a per season. PHI 7 days foliar, 21 days soil. REI 12 hr.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. One application per season. Do not exceed 0.044 lb ai/a per season.
- malathion (Malathion 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.28 lb ai/a per season. Limit 3 treatments. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.063 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.1 lb ai/a soil treatment. REI 12 hr. Do not exceed 0.063 lb ai/a per season. See label for recommended in-row application instructions.
- zeta-cypermethrin (Mustang) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

## Radish—Looper

### Includes

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 or 12 hr (see label). Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.056 to 0.066 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.022 lb ai/a beta-cyfluthrin or 0.044 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.44 lb ai/a per season. Oriental radish (Daikon) only.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.16 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.5 lb ai/a per season.
- spinetoram (Radiant SC) at 0.047 to 0.0625 lb ai/a. PHI 3 days. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per season. Limit 4 treatments.

- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.33 lb ai/a per season. Limit 4 treatments. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.05 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

## Radish—Wireworm

*Limonius* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- pyrethrins (as a mix with azadirachtin)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre, soil application. REI 4 hr. OMRI-listed for organic use.
- chloropicrin (Telone)—Preplant.
- chlorpyrifos (Lorsban 4E) at 2.75 lb ai/a as pre-plant incorporation for direct seeded or transplanted. PHI 21 days. REI 24 hr. **RESTRICTED USE IN OREGON.**
- diazinon (Diazinon 50W) at 3 to 4 lb ai/a. Broadcast just before planting and incorporate in to top 4 to 8 inches. REI 3 days.

## Rhubarb—Armyworm, cutworm, and looper

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Black cutworm (*Agotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

### Pest description and crop damage

*See:*

Common Pests of Vegetable Crops

### Biology and life history

*See:*

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, when bees are not present, may help. Beans, tomatoes, and late corn are most often “hoed” by cutworms. Attack varies in severity with locality and year.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin

- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- insecticidal soap (as a mix with spinosad)—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant-derived essential oils (rosemary, peppermint, etc.)—These have some efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Dipel Pro) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.5 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 qt product per acre. PHI 0 day. REI 4 hr.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a at plant, drip, foliar. PHI 1 day. REI 4 hr. Retreatment interval 3 days for foliar and 10 days for chemigation. Do not exceed 0.2 lb ai/a per season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.11 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season.
- flubendiamide/buprofezin (Vetiva) at 0.25 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 7 days. Do not exceed 0.79 lb ai/a per year.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 4 lb product/a. PHI 0 days. REI 4 hr.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/a per crop. Retreatment interval 3 days. Limit 4 treatments.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early-season, and 0.12 to 0.16 ai/a for mid- to late-season. REI 4 hr. PHI 1 day. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.2 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatment per season.
- spinosad (Entrust SC) at 0.05 to 0.12 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-season, and 0.12 lb ai/a mid- to late-season. PHI 7 days. REI 4 hr. Do not exceed 0.625 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary for heavy infestations. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.194 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per season.

## Rhubarb—Garden symphylan

*Scutigera immaculata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

## Management—biological control

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

## Management—cultural control

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied.

## Management—chemical control: HOME USE

- bifenthrin
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

## Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant soil fumigants.

## Rhubarb—Slug

### Includes

*Arion* spp.

Gray field slug (*Derocerus reticulatum*)

Black greenhouse slug (*Milax gagates*)

Large spotted garden slug (*Limax maximus*)

Marsh slug (*Derocerus laeve*)

Reticulated slug (*Prophysaon andersoni*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Slug Control

### Management—chemical control: HOME USE

Baits are the only registered chemical controls. These must be placed where slugs will encounter them in order to be effective. Baits are required year-round in moist, irrigated areas, but are most effective if placed after fall rains in dry conditions. Rain quickly degrades baits, so reapplication will be required. Cereal-based mini-pellets perform best in the PNW.

- iron phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.

### Management—chemical control: COMMERCIAL USE

- iron phosphate baits at 0.24 to 0.44 lb ai/a. PHI 0 days. REI no restrictions.
- metaldehyde baits—REI 12 hr.

## Rutabaga—see Turnip (roots and tops) and rutabaga

## Salsify—Aphid

### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Pea aphid (*Acyrtosiphon pisum*)

Potato aphid (*Macrosiphum euphorbiae*)

### Pest description, crop damage and life history

*See:*

## Common Pests of Vegetable Crops

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- plant-derived essential oils (clove, rosemary, peppermint, etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.16 lb ai/a PHI 7 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 0.365 lb ai/a per season
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil or 0.43 lb ai/a foliar. PHI 7 days foliar, 21 days soil. Retreatment interval 5 days. REI 12 hr. One soil treatment per season.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a per season.
- malathion (Malathion 8) at 1.25 lb ai/a. PHI 7 days. REI 24 hr. Retreatment interval 7 days. Limit 3 treatments per year.
- sulfoxaflor (Transform WG) at 0.023 to 0.031 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a. REI 12 hr. Do not exceed 0.188 lb ai/a per season. Soil applied.

## Salsify—Armyworm

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop.

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- plant-derived essential oils (rosemary, peppermint, etc.)—These have some efficacy against lepidopteran larvae. Some formulations are

OMRI-listed for organic use.

- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5) at 0.14 to 0.35 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F and Sevin Baits) at 1 to 2 lb ai/a foliar and 2 lb ai/a bait. PHI 7 days. REI 12 hr. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 3 days. Do not exceed 4 applications per crop or 0.2 lb ai/a per crop.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a for early season; 0.12 to 0.16 ai/a for mid to late season. REI 4 hr. PHI 1 day. Retreatment interval 14 days. Do not exceed 1 lb ai/a per season.
- spinetoram (Radiant SC) at 0.047 to .0.0625 lb ai/a. PHI 3 days. Retreatment interval 4 days. Do not exceed 0.219 lb ai/a per season. Limit 4 treatments per season.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.3 lb ai/a per season. Entrust SC is OMRI-listed for organic use.
- zeta cypermethrin (Mustang) 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.3 lb ai/a per season. Retreatment interval 4 days.

## Salsify—Wireworm

*Limonius* spp.

#### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

#### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

#### Management—chemical control: HOME USE

- bifenthrin (as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant.

## Shallot—see Leek and shallot

## Spinach—Aphid

#### Includes

Bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Melon aphid (*Aphis gossypii*)

#### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Check plants frequently after transplant or seedling emergence. Aphids often are concentrated in “hot spots.” Be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor plants particularly closely during April and May.

### **Management—cultural control**

Controlling weeds late in the season may help reduce overwintering populations. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- insecticidal soap (often as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant-derived essential oils (rosemary, peppermint, etc.)—These have some efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. REI 12 hr. PHI 7 days. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 0.375 lb ai/a per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—PHI 0 days. REI 4 hr. See label for rates. Acts slowly; apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- borate complex (Prev-Am Ultra) as 0.8% solution. Apply to complete coverage. REI 12 hr. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar or 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a or three applications per season. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.16 lb ai/a PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a soil and 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. Retreatment interval 5 days. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.24 lb ai/a foliar per season.
- imidacloprid (Provado, Prey) at 0.048 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/a per season.
- insecticidal soap (M-Pede) at 1 to 2%. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1 lb ai/a. PHI 7 days. REI 24 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. Retreatment interval 3 days. REI 12 hr. Do not graze or feed treated crop

refuse to livestock. Do not exceed 0.2 lb ai/a per season.

- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- pyriproxyfen (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- sulfoxaflor (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments. Do not exceed 0.266 lb ai/a per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil application. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Spinach—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Black cutworm (*Agrotis ipsilon*)

Variegated cutworm (*Peridroma saucia*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### Management—chemical control: HOME USE

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.020 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. An adjuvant improves control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.

- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at plant or PPI. Do not exceed 0.1 lb ai/a per season as an at-plant treatment.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- borate complex (Prev-Am Ultra) at 0.4% solution. Apply to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 6 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Retreatment interval 3 days foliar, 10 days drip chemigation. Do not exceed 0.2 lb ai/a per season
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.013 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze. For armyworm.
- GS-omega/kappa-Hxtx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/a per crop. Retreatment interval 3 days.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 3.6 lb ai/a per season. Limit 8 treatments per year. Do not apply to seedlings less than 3 inches in diameter or when temperature is below 32°F.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early-season, or 0.12 to 0.16 ai/a mid- to late-season. PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin, Permethrin Cutworm Bait) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 3 days foliar, 10 days bait. Do not graze or feed treated crop refuse to livestock. Do not exceed 0.2 lb ai/a foliar or 1 lb ai/a bait per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Limit 6 treatments per season. Armyworms only.
- spinosad (Success, Entrust SC) at 0.063 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- *Spodoptera frugiperda* (Fawligen) at 1 to 2.4 fl oz product per acre. PHI 0 days. REI 4 hr. Beet armyworm and fall armyworm only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early year; 0.12 lb ai/a mid to late year. PHI 7 days. REI 4 hr. Do not exceed 0.625 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary for heavy infestations. An adjuvant improves control. Armyworm only.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a for cutworm, 0.04 to 0.05 lb ai/a for armyworm. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Spinach—Collembola (springtail)

Primarily *Onychiurus pseudarmatus*

**Pest description and crop damage** Small, white, slow-moving, soil-dwelling insects that feed on germinating seeds or roots of small plants, causing reduced stands and loss of vigor in surviving plants. They usually are in localized or irregular spots in the field.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 6 lb ai/a per season.
- malathion (Malathion 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Washington and Oregon only. Limit 2 treatments.

## Spinach—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Western striped cucumber beetle (*Acalymma trivittatum*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Specific treatment thresholds have not been established for this pest on spinach. Adults are foliage feeders, and grubs chew on and tunnel through roots; scout accordingly. Late year infestations are insignificant. If damaging numbers are encountered during mid year, excessive foliage loss may reduce crop production. In Virginia, the following recommendations are made: to prevent cucumber beetle damage to seedlings, treat when one beetle per 10 row feet is found.

### Management—cultural control

Commercial row crop covers provide good protection from cucumber beetles, provide late-frost protection, and help retain moisture. Sometimes, a crop planting can be delayed until after beetles disperse and deposit most of their eggs. Delaying planting until warmer weather also gives crops a greater chance of outgrowing beetle injury. Trap crops sometimes can be used to draw beetles away from the main crop. Trap-cropping is an unproven control method in Oregon.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/a foliar and 0.23 to 0.27 lb ai/a soil. PHI 7 day foliar; 21 days soil. REI 12 hr. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

**Note:** Carbaryl, diazinon, methomyl (Lannate), or permethrin applied to control other pests usually controls cucumber beetles.

## Spinach—European cranefly

*Tipula paludosa*

**Pest description and crop damage** Small, gray-brown, worm-like larvae that develop a tough skin and are commonly called leatherjackets. They feed on clover and a number of vegetables. They are particularly damaging to seedling vegetables.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- plant-derived essential oils (rosemary, peppermint, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- azadirachtin (Neemix 4.5)— See label for rates. REI 4 hr. Acts slowly; apply early. Thorough coverage and repeat applications are necessary.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Limit 5 treatments per year. Do not exceed 6 lb ai/a per season.

## Spinach—Garden symphylan

*Scutigera immaculata*

**Pest description, crop damage and life history**

See:

Common Pests of Vegetable Crops

Biology and Control of the Garden Symphylan

**Pest monitoring** Infested soil can be treated with insecticides, but the effect is limited because of symphylan’s ability to migrate deep into the soil. Insecticides may help give the plants a chance to establish in a protected zone. In general, preplant field evaluation for symphylans involves grid sampling at one acre intervals, digging 6 x 6 x 12 inch holes (0.25 cubic foot), spreading and carefully examining the soil from the hole, and using an action threshold of 0.5 to 1 symphylans per sample.

**Management—biological control**

Many organisms prey on symphylans in the field, including true centipedes, predatory mites, predaceous ground beetles, and various fungi. However, little is known about their effect on symphylan populations.

**Management—cultural control**

Symphylan damage generally is associated with soils that are high in organic matter content and have good soil structure. Symphylans do not thrive in either compact or sandy soils, because these soils do not provide them with adequate tunnels for their movement (symphylans cannot make their own burrows). There is some evidence that packing down the soil surface after planting may reduce injury.

Flooding for 2 to 3 weeks has controlled symphylans in some situations but has been unsuccessful in others. Even in the best circumstances, flooding only reduces populations, and they can increase when conditions are again favorable. Effectiveness of rotations with nonhost crops has not been studied.

**Management—chemical control: HOME USE**

- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

**Management—chemical control: COMMERCIAL USE**

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at plant or PPI. Do not exceed 0.1 lb ai/a per season as an at-plant treatment.
- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant. PHI 40 days. REI 12 hr.
- chloropicrin (Telone)—Preplant.

## Spinach—Leafminer

**Includes** spinach leafminer (*Pegomya hyoscyami*)

**Pest description and crop damage** Adults are small black to gray flies with yellow markings. The body is covered with long stiff bristles. Larvae are a nearly translucent white or yellow color and about 0.25 inch long when mature. Eggs are white, cylindrical, and laid singly or in small groups. Both larvae and adults damage plants. Larval feeding results in slender, winding trails on the leaves, which form large white blotches if mining becomes severe. Adults can make as many as 100 feeding punctures on a single leaf. Around 5% of these punctures may contain actively feeding larvae. Excessive mining renders leaves unmarketable, reduces photosynthetic capacity, and provides easy access for disease organisms.

**Biology and life history** Leafminers overwinter as pupae in the soil. Adults emerge in late May, mate, and females lay eggs on the undersides of beet and chard leaves or on lambsquarters. The eggs hatch in about 4 days, and the small maggots eat into the leaf. There may be several maggots in a leaf. When mature, larvae fall to the ground and pupate just under the soil surface. Adults emerge in 10 to 25 days and begin laying eggs for another generation. There are at least three generations each year.

**Pest monitoring** Regularly check young seedlings for leaf mines. Most mines occur on cotyledons and the first true leaves. Some mines are more visible when seen from the underside of the leaf. If leafminer populations build to high levels when seedlings have four to five leaves, a chemical treatment may be necessary. Treat if you find more than an average of one mine per leaf in your overall field sample. To be effective, sprays must be applied to the larval stage.

**Management—biological control**

Natural enemies, especially parasitic wasps, commonly reduce populations of leafminers, unless they are killed by insecticides applied to control other pests. To avoid killing beneficials, choose selective pesticides for treating other pests, whenever possible. Other parasites attack leafminers, but

because leafminers feed within the leaf, they generally are protected from most predators.

### Management—cultural control

A related genus, *Liriomyza* leafminers attack a wide variety of vegetable crops. Where possible, avoid planting next to infested fields, especially those near harvest. Postharvest disking of fields destroys pupae and reduces migration of adult flies into susceptible fields. Row covers work well in excluding egg-laying female flies.

*Home gardeners:* Remove and destroy affected leaves. Bag and eliminate affected leaves, do not compost them.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season. Addition of a silicone surfactant will increase translaminar movement of abamectin.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- chlorantraniliprole (Coragen) at 0.065 to 0.098 lb ai/a as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a per season.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyromazine (Trigard) at 0.125 lb ai/a. PHI 7 days. REI 12 hr. Do not make more than six applications per crop.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.13 lb ai/a foliar, 0.23 to 0.27 lb ai/a soil. PHI 7 days for foliar, 21 days for soil. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a foliar or 0.532 lb ai/a soil per season.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval-7 days. Do not exceed 0.09 lb ai/a per season.
- *Isaria fumosorosea* (PFR-97 20%WDG) at 1 to 2 lb product per acre. PHI 0 days. REI 4 hr. Repeat every 3 to 10 days as needed. OMRI-listed for organic use.
- permethrin (Loveland Permethrin) at 0.1 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 3 days. Do not graze or feed treated crop refuse to livestock. Do not exceed 0.6 lb ai/a per season.
- spinetoram (Radiant SC) at 0.047 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.094 to 0.156 lb ai/a. PHI 1 day. REI 4 hr. Treat eggs, at hatch, and small larvae. Do not exceed 0.45 lb ai/a per crop. An adjuvant improves control. Spinosad takes several days to achieve full effect. Monitor fields and pest populations carefully. Multiple applications may be necessary. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a, soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season. See label for recommended in-row application instructions. Suppression only.

## Spinach—Looper

**Includes** alfalfa looper (*Autographa californica*), cabbage looper (*Trichoplusia ni*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** A sweep net can be used to sample for large larvae. Take a minimum of 100 sweeps divided into groups of 10 in different parts of the field and along the margins. Sequential sampling that involves fewer samples, and presence-absence sampling that does not involve counting, also may be used.

Pheromone traps can be used to monitor for the emergence of adult male moths. Alfalfa loopers are trapped more often than cabbage loopers, sometimes leading to misreading which looper is the primary pest.

### **Management—biological control**

Cabbage loopers have many natural enemies that may keep them below economic levels if they are not killed by insecticide treatments for other pests. These include several important, naturally occurring parasites. A nuclear polyhedrosis virus disease is also important under certain circumstances.

Be sure to monitor for natural enemies. If looper populations are close to treatment thresholds, but you find a significant percentage of parasitized or disease-killed individuals, delay treatment for a few days to see if these natural controls will bring populations down on their own. If treatment is necessary, *Bacillus thuringiensis* insecticide minimizes injury to natural enemies.

### **Management—cultural control**

Use row covers after planting to prevent egg-laying by adults. Rotate plantings, and harvest without delay at the end of the season. Remove plant debris from the field at the end of harvest.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- cyfluthrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.019 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.1 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- borate complex (Prev-Am) at 0.4% solution. Apply to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Retreatment interval 3 days
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.038 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- emamectin benzoate (Proclaim) at 0.01 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Do not graze.
- flubendiamide/buprofezin (Vetiva) at 0.21 to 0.42 lb ai/a. PHI 1 day. REI 12 hr. Limit 2 treatments. Retreatment interval 7 days. Do not exceed 0.83 lb ai/a per year.
- GS-omega/kappa-Hxtx-Hv1a (Spears Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/a per crop. Retreatment interval 3 days.

- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 3.6 lb ai/a per season. Limit 8 treatments per year. Do not apply to seedlings less than 3 inches wide or when temperatures are below 32°F.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a early-season, or 0.12 to 0.16 ai/a mid- to late-season. REI 4 hr. PHI 1 day. Do not exceed 1 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 3 days. Do not graze or feed treated crop refuse to livestock. Do not exceed 0.6 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot. Cabbage looper only.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-year, or 0.12 lb ai/a mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 0.12 lb ai/a per application or 0.625 lb ai/a per season. Reapplication on a 10- to 14-day schedule may be necessary under heavy infestations. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.2 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Spinach—Lygus bug

*Lygus* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—chemical control: HOME USE

Follow information given on the label about the timing and cutoff date for the particular vegetable you are spraying.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)— Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.4 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 40 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a avermectin or 0.4 lb ai/a bifenthrin per year. Limit 2 treatments.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.096 lb ai/a. PHI 40 days. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin per season. Retreatment interval 7 days.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 6 lb ai/a per season. Retreatment interval 7 days. Limit 5 treatments.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season.
- malathion (Malathion 8) at 1 to 1.5 lb ai/a. PHI 7 days. REI 24 hr. Washington and Oregon only. Limit 2 treatments.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Spinach—Wireworm

*Limoni* spp.

### Pest description, biology, life history and crop damage

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

**Management—chemical control: HOME USE**

- bifenthrin (as a mix with zeta-cypermethrin).
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- bifenthrin (Capture LFR) at 0.04 to 0.08 lb ai/a at plant or PPI. Do not exceed 0.1 lb ai/a per season as an at-plant treatment.
- bifenthrin/avermectin (Athena) at 0.06 to 0.12 lb ai/a at plant. PHI 40 days. REI 12 hr.
- chloropicrin (Telone)—Preplant soil fumigants.
- diazinon (Diazinon 50W) at 3 to 4 lb ai/a. Broadcast before planting and incorporate into top 4 to 8 inches. REI 3 days.

## Squash—see Pumpkin and squash

## Tomato—Aphid

**Includes**

Green peach aphid (*Myzus persicae*)

Potato aphid (*Macrosiphum euphorbiae*)

**Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Management—cultural control**

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, thyme, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- acetamiprid (Assail 30SG) at 0.038 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 0.3 lb ai/a or four treatments per season.
- afidopyropen (Sefina Inscalis) at 0.01 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. PHI 0 days. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12

lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.

- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Limit 4 treatments. Do not exceed 0.32 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.4 lb ai/a imidacloprid and 0.24 lb ai/a bifenthrin. Retreatment interval 10 days. Do not graze livestock in treated areas or cut for feed.
- borate complex (Prev-Am Ultra) apply at 0.8% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- *Chromobacterium subsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- dimethoate (Dimethoate 400) at 0.25 to 0.5 lb ai/a. PHI 7 days. REI 48 hr. Retreatment interval 6 days. Do not exceed 1 lb ai/a per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar and 21 days for soil. REI 12 hr. Do not exceed per season 0.266 lb ai/a foliar or 0.532 lb ai/a for soil.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season.
- flonicamid (Beleaf 50SG) at 0.089 to 0.133 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Retreatment interval 7 days. Limit 3 treatments for field and 2 treatments for greenhouse per year.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a foliar, 0.27 to 0.37 lb ai/a. PHI 1 day foliar, 45 days soil. REI 4 hr. Foliar retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Provado, Prey) at 0.048 to 0.078 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil or 0.047 to 0.079 lb ai/a foliar. PHI 0 day foliar; 21 days soil. REI 12 hr. Retreatment interval 5 days foliar. Do not exceed 0.38 lb ai/a soil per application or 0.24 lb ai/a foliar per season.
- imidacloprid (Admire Pro) at 0.021 lb ai/1,000 plants soil treatment in greenhouse or 0.016 lb ai/10,000 plants foliar treatment in planthouse. PHI 0 days. REI 12 hr. Limit one treatment per crop season.
- insecticidal soap (M-Pede) at 1 to 2% solution. Potassium salts of fatty acids. See label for gal/a. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- malathion (Malathion 8) at 1.5 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 4 treatments.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 6.3 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.14 lb ai/a per year. Apply by ground equipment.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season
- sulfoxaflo (Closer SC) at 0.023 to 0.031 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Tomato—Armyworm and cutworm

### Includes

Beet armyworm (*Spodoptera exigua*)  
Bertha armyworm (*Mamestra configurata*)  
Western yellowstriped armyworm (*Spodoptera praefica*)  
Black cutworm (*Agotis ipsilon*)  
Variegated cutworm (*Peridroma saucia*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** In California, in fresh market tomatoes, sampling should begin when fruit appears. A 5-minute timed search helps determine the need for treatment. On average, if one or more larvae or egg masses are found in 5 minutes, treatments may be justified.

### **Management—cultural control**

Weed control is important. Lambsquarters and wild mustard attract egg-laying females and provide a source of food for larvae. Fall tillage can help destroy overwintering pupae.

*Home gardeners:* Control weeds, grasses, and debris in the vegetable garden that provide cover; hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant essential oils (rosemary, etc.)—Some have demonstrated efficacy against lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- azadirachtin (Neemix 4.5)—See label for rates. Acts slowly; apply early. REI 4 hr. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. Add an appropriate spreader-sticker to enhance control. most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.017 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Limit 4 treatments. Do not exceed 0.32 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.048 to 0.116 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.4 lb ai/a bifenthrin. Retreatment interval 10 days. Do not graze livestock in treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- borate complex (Prev-Am Ultra) apply at 0.4% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F, Sevin 5 Bait) at 1 to 2 lb ai/a foliar; 2 lb ai/a bait. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 5 days for foliar and 10 days for chemigation.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.049 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not

exceed 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.

- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.6 lb ai/a per season. Retreatment interval 5 days. Greenhouse only. Do not use on tomato varieties with a diameter of less than one inch when mature.
- *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.033 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- diazinon (Diazinon 50W) at 2 to 4 lb ai/a preplant. REI 2 days. One treatment per season. Cutworms only.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season.
- flubendiamide/buprofezin (Vetiva) at 0.25 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days. Do not exceed 0.79 lb ai/a per year.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.26 lb ai/a per season. An adjuvant improves control.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- methomyl (Lannate SP) 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 6.3 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a (early-season) or 0.12 to 0.25 lb ai/a (mid- to late-season). PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 1 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Loveland Permethrin and Permethrin Bait) at 0.05 to 0.2 lb ai/a foliar and 0.1 to 0.2 lb ai/a bait. PHI 0 days. REI 12 hr. Do not exceed 0.6 lb ai/a per season. Retreatment interval 7 days.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling fruiting vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.063 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- Spodoptera frugipereda (Fawcigen) at 1 to 2.4 fl oz product per acre. PHI 0 day. REI 4 hr. Beet armyworm.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-year, or 0.12 to 0.25 lb ai/a mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 1 lb ai/a per season. Use of a spreader-binder is recommended.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

See:

Corn, sweet—Armyworm

Corn, sweet—Cutworm

## Tomato—Colorado potato beetle

*Leptinotarsa decemlineata*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Colorado potato beetle populations initially are aggregated but tend to disperse over time. Plants can lose up to 30% of their foliage without yield loss. Generally, insecticides are not needed unless beetles or larvae average more than one per plant.

## Management—biological control

Beneficial insects, such as predatory stink bugs and parasitic flies, and birds help to reduce Colorado potato beetle numbers somewhat, but they cannot be counted on to provide adequate control.

## Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.056 lb ai/a per season.
- acetamiprid (Assail 30SG) at 0.028 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 4 treatments per year. Do not exceed 0.3 lb ai/a or four treatments per season.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.4 lb ai/a bifenthrin. Retreatment interval 10 days. Do not graze livestock in treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a as chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 5 days for foliar and 10 days for chemigation.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cyclaniliprole (Harvanta SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- cyromazine (Trigard) at 0.125 lb ai/a as a foliar spray. Minimum interval between treatments 7 days. PHI 7 days. REI 12 hr. Do not apply more than 0.75 lb ai/a per season. Suppression only.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day (foliar), 21 days (soil). REI 12 hr. Do not exceed 0.266 lb ai/a (foliar) or 0.532 lb ai/a (soil) per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Do not feed or graze livestock on treated vines.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per sea-

son.

- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil or 0.047 to 0.079 lb ai/a foliar. PHI 21 days soil; 0 day foliar. Retreatment interval 5 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil per application or 0.24 lb ai/a foliar per season.
- imidacloprid (Provado, Prey) at 0.048 to 0.078 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not use more than 0.24 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- oxamyl (Vydate L) at 0.5 to 1 lb ai/a. PHI 3 days. REI 48 hr. Do not exceed 8 lb ai/a per season. Drip irrigation permitted.
- permethrin (Ambush 25WP, Pounce 25WP) at 0.05 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a Pounce or 1.2 lb ai/a Ambush per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Do not apply to seedling fruiting vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed or 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.14 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Tomato—Flea beetle

**Includes** tuber flea beetle (*Epitrix tuberis*)

### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or after the seedlings emerge. Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 ft of borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest and foliage is declining as a food source for the beetles, spot treat according to the distribution of the flea beetle.

### **Management—cultural control**

Research in California has shown that seedling damage is significantly higher in fields previously planted to tomatoes. If possible, rotate tomatoes with a nonhost crop. In fields not previously planted to tomatoes, flea beetle infestations are usually located at field borders.

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop, but this has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- imidacloprid

- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad
- zeta-cypermethrin

#### Management—chemical control: COMMERCIAL USE

- azadirachtin (Neemix 4.5)— See label for rates. REI 4 hr. Acts slowly; apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Limit 4 treatments. Do not exceed 0.32 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.06 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.4 lb ai/a bifenthrin. Retreatment interval 10 days. Do not graze livestock in treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- clothianidin (Belay) at 0.05 to 0.067 lb ai/a foliar, 0.15 to 0.2 lb ai/a soil. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per season.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar or 0.23 to 0.27 lb ai/a for soil. PHI 1 day foliar, 21 days for soil. REI 12 hr. Do not exceed, per season, 0.266 lb ai/a foliar or 0.532 lb ai/a for soil.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a season. Do not feed or graze livestock on treated vines.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a. Soil application only. PHI 21 days. REI 12 hr. Do not exceed 0.38 lb ai/a per year.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- thiamethoxam (Actara) at 0.031 to 0.047 lb ai/a. Apply high rates for heavy infestations. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- tolfenpyrad (Torac) at 0.14 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Tomato—Spider mite

*Tetranychus* spp.

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological control

Spider mite populations are held down in cool conditions early in the season by various predators such as pirate and big-eyed bugs. Predator mites are effective predators of spider mites and are available.

### Management—cultural control

Avoid early season applications of insecticides, which will reduce populations of beneficial insects. Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. Mites can be hosed from plants with a strong stream of water. Excessive nitrogen fertilization may cause population buildup.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Complete coverage, especially of undersides of leaves, is essential. Repeat applications may be required. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils (cottonseed, clove, garlic, etc.) have proven effective against mites. Some formulations are OMRI-listed for organic use.
- sulfur (often as a mix with pyrethrins).

### Management—chemical control: COMMERCIAL USE

- abamectin (Agri-Mek SC) at 0.009 to 0.019 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed two sequential applications or 0.056 lb ai/a per season.
- acequinocyl (Kanemite 15SC, Shuttle O) at 0.3 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.6 lb ai/a per season.
- bifenazate (Acramite 50WS) at 0.375 to 0.5 lb ai/a. PHI 3 days. REI 12 hr. Limit 1 field treatment per year.
- bifenazate (Floramite SC) at 0.063 to 0.125 lb/100 gal. PHI 3 days. REI 12 hr. Do not exceed 1 lb ai/a per season. Limit 2 treatments. For greenhouse application only.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Limit 4 treatments. Do not exceed 0.32 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- borate complex (Prev-Am Ultra) apply at 0.4% solution. Spray to complete coverage. REI 12 hr. OMRI-listed for organic use.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.6 lb ai/a per season. Greenhouse only. Retreatment interval 5 days. Do not use on tomato varieties with a diameter of less than one inch when mature.
- cyflumetofen (Nealta) at 0.179 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.357 lb ai/a, Knockdown only. Application should be timed to coincide with recommended miticide treatment.
- etoxazole (TetraSan) at 0.025 to 0.625 lb ai/100 gal (covers about 20,000 sq ft). PHI 1 day. REI 12 hr. (indoor grown only). Do not exceed 2 applications per cropping season. Do not exceed 1.25 lb per acre per application.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- fenpyroximate (Miteus) at 0.105 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.21 lb ai/a per season. Limit 2 applications. Retreatment interval 14 days.
- hexythiazox (Onager) at 0.94 to 1.88 lb ai/a. PHI 1 day. REI 12 hr. One treatment. Greenhouse only.
- insecticidal soap (M-Pede) at 2% solution. See label for gal/a rate. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- malathion (Malathion 8) at 1.5 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 4 treatments.
- *Metarhizium anisopliae* (Met52 EC) at 40 to 80 fl oz/100 gal as drench or 8 to 64 fl oz/a foliar. PHI 0. REI 4 hr.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a PHI 1 day. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 0.4 lb ai/a per season.

## Tomato—Tomato fruitworm (Corn earworm)

*Helicoverpa zea*

**Pest description and crop damage** Tomato fruitworm moths are about 0.75 inch long, robust, with a wingspan of 1 to 1.5 inches, and range from olive green to tan to dark reddish brown. Eggs are pale green at first, turning yellowish and finally gray. Young larvae are greenish with black heads and conspicuous black hairs on the body. Fully developed worms are about 1.5 inches long and range from pale green or pinkish to brown. Pupae are about 0.75 inch long and mahogany brown. They usually are found 2 to 4 inches deep in the soil. The tomato fruitworm may be present throughout the season but is most abundant during August and September. Larvae feed on leaves, and burrow into fruit. This pest also is known as the corn

earworm, as it also attacks corn.

**Biology and life history** The tomato fruitworm overwinters as a pupa in the soil except in some areas in the North, where it is unable to survive the winter. Adults emerge in late May and June and begin laying eggs on suitable hosts. Egg laying occurs throughout the tomato growing season. Fruitworm moths are most active during evening and night.

Female moths lay their eggs singly. Eggs are white at first but develop a dark red or brown ring within 24 hours. Eggs hatch in 5 to 7 days. Larvae feed for 2 to 3 weeks before pupating in the soil. Adults emerge in about 2 weeks and lay eggs on leaves. Moths move northward and establish infestations in areas where they cannot overwinter.

The summer generations overlap, resulting in a regular and gradual build-up of the population from the beginning to the end of the year. There are two to three generations each year.

**Pest monitoring** Check leaves for the presence of eggs or larvae and pick these off. A magnifying glass may be required.

#### **Management—biological control**

Many predators and parasites attack fruitworm eggs, including several species of *Trichogramma*. Most parasitized eggs turn black, but there may be a lag period before they do so. Releases of trichogramma wasps may give mixed results. Generalist predators such as lacewings, minute pirate bugs, and damsel bugs feed on corn earworm eggs and small larvae.

#### **Management—cultural control**

Plow or dig up plants in the fall to prevent overwintering.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a as soil, chemigation or foliar treatment. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 5 days for foliar and 10 days for chemigation.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.059 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.172 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Do not exceed 0.6 lb ai/a per season. Greenhouse only. Do not use on tomato varieties with a diameter of less than one inch when mature.
- cyclaniliprole (Harvanta SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. Retreatment interval 7 days. REI 12 hr. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per sea-

son.

- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- fenpyroximate (Miteus) at 1.25 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2.5 lb ai/a per season. Limit 2 applications.
- flubendiamide/buprofezin (Vetica) at 0.25 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days. Do not exceed 0.79 lb ai/a per year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- HzNPV (Gemstar LC) polyhedral virus at 4 to 10 fl oz/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.26 lb ai/a per season.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 6.3 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 0 days. Retreatment interval 7 days. REI 12 hr. Do not exceed 0.6 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Tomato—Tomato hornworm

*Manduca quinquemaculata*

**Pest description and crop damage** The tomato hornworm larvae is over 3 inches long when full grown, green, with eight chevron-shaped white stripes and a distinctive large “horn” on the posterior end of its body. Pupae are brown or reddish brown and up to 2.25 inches long. The adult is a large mouse-brown moth with narrow wings and a wingspan of up to 5 inches. Eggs are light green or yellow turning white at maturity. Hornworms feed on blossoms, leaves, and fruit. At high populations, they can defoliate plants extensively and scar the fruit. They are rarely a problem in the warmer interior climates unless natural enemies are disrupted.

**Biology and life history** In late spring, the adult moth lays eggs on the underside of tomato leaves. The eggs hatch in 6 to 8 days. The larvae pass through five or six stages before reaching full growth in 3 to 4 weeks. The full grown larvae burrow into the soil, where they transform into the pupal stage. The hornworm remains in the pupal stage in the soil all winter until the soil begins to warm in the spring. The moths emerge from the soil in the spring and mate. The females begin to deposit eggs on the tomato plants for the next brood of hornworms.

**Pest monitoring** Treat hornworms only if they are causing extensive foliage damage, or if they are feeding on fruits. Look for the presence of hornworms on the plant as you sample to determine if damage is the result of hornworm or armyworm activity. Hornworm feeding produces larger, deeper cavities than those caused by beet armyworm.

### Management—biological control

There are several important, naturally occurring parasites that help control hornworms in tomatoes. Conserving these parasites by not treating with disruptive pesticides, particularly early in the year before fruit begin to mature, is the preferred management approach.

### Management—cultural control

*Home gardeners:* Hand-pick hornworm larvae.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- esfenvalerate
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.

- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

- alpha-cypermethrin (Fastac EC) at 0.014 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin/avermectin (Athena) at 0.05 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- beta-cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.132 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.089 to 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 8 lb ai/a per season.
- chlorantraniliprole (Coragen) at 0.026 to 0.098 lb ai/a foliar; 0.045 to 0.098 lb ai/a drip chemigation. PHI 1 day. REI 4 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 5 days for foliar and 10 days for chemigation.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.049 to 0.088 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb. ai of lambda-cyhalothrin or 0.2 lb. ai of chlorantraniliprole per acre per growing season.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.
- chlorfenapyr (Pylon) at 0.1 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.6 lb ai/a per season. Greenhouse only.
- cryolite (Kryocide) at 7.7 to 15.4 lb ai/a. PHI 14 days. REI 12 hr. OMRI-listed for organic use.
- cyclaniliprole (Harvanta 50SL) at 0.036 to 0.054 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.22 lb ai/a per year.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.263 lb ai/a per season.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 to 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.168 lb ai/a per season.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season.
- esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Do not graze.
- fenpropathrin (Danitol 2.4EC) at 0.2 lb ai/a. PHI 3 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.8 lb ai/a per season.
- flubendiamide/buprofezin (Vetica) at 0.25 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days. Do not exceed 0.79 lb ai/a per year.
- gamma-cyhalothrin (Declare) at 0.008 to 0.015 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.18 lb ai/a per season.
- indoxacarb (Avaunt) at 0.045 to 0.065 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 5 days. An adjuvant improves control. Do not exceed 0.26 lb ai/a per season. Insect feeding stops soon after application, but 3 to 4 days are required for maximum effect.
- lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a per season.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.064 to 0.072 lb ai/a. PHI 5 days. REI 24 hr. Retreatment interval 5 days. Do not exceed 0.36 lb ai/a of lambda-cyhalothrin or 0.172 lb ai/a of thiamethoxam per season.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 1 day. REI 48 hr. Do not exceed 6.3 lb ai/a per season.
- methoxyfenozide (Intrepid 2F) at 0.06 to 0.12 lb ai/a (early-season) or 0.12 to 0.25 lb ai/a (mid- to late-season). PHI 1 day. REI 4 hr. Do not exceed 1 lb ai/a per season.
- novaluron (Rimon 0.83EC) at 0.058 to 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.2 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.6 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatment per season. Do not apply to seedling fruiting vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed 0.45 lb ai/a per crop. Limit 6 treatments per season. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/a early-year, or 0.12 to 0.25 lb ai/a mid- to late-year. PHI 7 days. REI 4 hr. Do not exceed 1

lb ai/a per season.

- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per season.

## Tomato—Whitefly

### Includes

Greenhouse whitefly (*Trialeurodes vaporariorum*)

Silverleaf whitefly (*Bemesia argentifolii*)

Sweetpotato whitefly (*Bemesia tabaci*)

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—cultural control

Inspect new plants before purchase: infestations often are introduced. Encourage natural enemies such as ladybird beetles, spiders, and parasitic wasps. Avoid use of broad-spectrum insecticides which reduce populations of these.

### Management—chemical control: HOME USE

For best results, direct spray toward undersides of leaves. Read label application instructions carefully.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (usually as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- deltamethrin
- esfenvalerate
- gamma-cyhalothrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- imidacloprid
- insecticidal soap—May require several applications. Complete coverage, especially under leaves, is essential. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 30SG) at 0.047 to 0.075 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a or four treatments per season.
- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.096 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.12 lb ai/a beta-cyfluthrin or 0.24 lb ai/a imidacloprid per season.
- bifenthrin (Brigade WSB) at 0.033 to 0.08 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Limit 4 treatments. Do not exceed 0.32 lb ai/a per season.
- bifenthrin/avermectin (Athena) at 0.09 to 0.12 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.056 lb ai/a avermectin or 0.2 lb ai/a bifenthrin per season.
- bifenthrin/imidacloprid (Brigadier) at 0.08 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.24 lb ai/a imidacloprid and 0.4 lb ai/a bifenthrin per season. Retreatment interval 10 days. Do not graze livestock in treated areas or cut for feed.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.1 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.42 lb ai/a per season. Limit 4 treatments.
- buprofezin (Talus 70DF) at 0.26 to 0.4 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2 applications per growing cycle. Retreatment interval 5 days. Greenhouse only.
- *Chenopodium ambrosioides* extract (Requiem 25EC) at 4 to 6 pints formulated product per acre. REI 4 hr. Use high rate when conditions are favorable for heavy pressure. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.175 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.

- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.11 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year.
- dinotefuran (Scorpion 35SL) at 0.05 to 0.18 lb ai/a foliar and 0.23 to 0.27 lb ai/a for soil. PHI 1 day (foliar), 21 days (soil). REI 12 hr. Do not exceed 0.266 lb ai/a (foliar) or 0.532 lb ai/a (soil) per season.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.5 lb ai/a per season.
- fenpyroximate (Miteus) at 1.25 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 2.5 lb ai/a per season. Limit 2 applications.
- flubendiamide/buprofezin (Vetiva) at 0.29 to 0.35 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 treatments. Retreatment interval 5 days. Do not exceed 0.79 lb ai/a per year.
- flupyradifurone (Sivanto 200SL) at 0.14 to 0.18 lb ai/a foliar, 0.27 to 0.37 lb ai/a soil. PHI 1 day foliar, 45 days soil. REI 4 hr. Foliar retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.
- imidacloprid (Provado, Prey) at 0.04 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- imidacloprid (Admire Pro) at 0.25 to 0.38 lb ai/a soil or 0.047 to 0.079 lb ai/a foliar. PHI 0 foliar; 21 days soil. REI 12 hr. Retreatment interval 5 days foliar. Do not exceed 0.38 lb ai/a soil per application or 0.24 lb ai/a foliar per season.
- imidacloprid (Admire Pro) at 0.021 lb ai/1,000 plants soil treatment in greenhouse or 0.016 lb ai/10,000 plants foliar treatment in planthouse. PHI 0 days. REI 12 hr. Limit one treatment per crop season.
- *Metarhizium anisopliae* (Met52 EC) at 40 to 80 fl oz/100 gal as drench or 8 to 64 fl oz/a foliar. PHI 0. REI 4 hr.
- novaluron (Rimon 0.83EC) at 0.078 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.23 lb ai/a per season.
- pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.14 lb ai/a per year. Apply by ground equipment.
- pyriproxyfen (Knack) at 0.054 to 0.067 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.109 lb ai/a per season.
- spiromesifen (Oberon 2SC) at 0.11 to 0.13 lb ai/a PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 treatments per year. Do not exceed 0.4 lb ai/a per season.
- spirotetramat (Movento) at 0.06 to 0.08 lb ai/a. PHI 1 day. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.16 lb ai/a per crop season.
- thiamethoxam (Actara) at 0.047 to 0.086 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.172 lb ai/a soil applied. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai/a per season.
- thiamethoxam/chlorantraniliprole (Durivo) at 0.195 to 0.257 lb ai/a applied to the soil. PHI 30 days. REI 12 hr. Do not exceed 0.172 lb ai of thiamethoxam or 0.2 lb ai of chlorantraniliprole per acre per growing season.

## Tomato—Wireworm

*Limoniusspp.*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

See:

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- bifenthrin (often as a mix with zeta-cypermethrin)
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- bifenthrin (Brigade WSB, Capture LFR) at 0.05 to 0.08 lb ai/a in furrow with seed or transplant. REI 12 hr.
- bifenthrin/avermectin (Athena) at 0.058 to 0.116 lb ai/a at plant. REI 12 hr.
- chloropicrin (Telone)—Preplant soil fumigants.
- diazinon (Diazinon 50W) at 3 to 4 lb ai/a. Broadcast before planting and incorporate into the top 4 to 8 inches. REI 2 days.

## Turnip (roots and tops) and rutabaga—Aphid

### Includes

Cabbage aphid (*Brevicoryne brassicae*)

Green peach aphid (*Myzus persicae*)

Turnip aphid (*Hyadaphis pseudobrassicae*)

### Pest description, crop damage and life history

See:

## Common Pests of Vegetable Crops

There may be as few as two generations (the green peach aphid) or as many as 16 generations each year (the cabbage aphid), depending on the species and climate.

**Pest monitoring** Check fields frequently after seedling emergence. If aphids become numerous, increase frequency of sampling. Aphids often are concentrated in hot spots or near the field margin. Note the presence of any hot spots, but avoid sampling only those areas. Also, be sure to look for evidence of biological control; i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor fields particularly closely during April and May.

### Management—biological control

Many parasites and predators attack aphids. Early year aphids have many natural enemies that frequently bring them under control later in the year. Among the more common predators are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Populations of green peach aphids are reduced in winter by a parasitic fungus, *Entomophthora aphidis*.

Monitor the proportion of aphid mummies relative to unparasitized aphids and the numbers of predators such as lady beetles. If the proportion of mummies is increasing, or predators appear to be gaining control, and aphid populations are not yet damaging, avoid sprays that will disrupt these natural enemies if the crop is not entering a susceptible stage. Most materials available for aphid control are highly disruptive of natural enemy populations.

### Management—cultural control

Destroy infested crops immediately after harvest to prevent dispersal. Destroying weed hosts late in the year may help destroy overwintering populations. Roguing diseased plants early may help slow the spread of aphid-vectored diseases. Aphid populations tend to be higher in crops that are fertilized liberally with nitrogen.

### Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen.

*Home gardeners* can use row covers or wash aphids from plants with a strong stream of water.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- imidacloprid
- insecticidal soap (as a mix with spinosad)—May require several applications. Do not use on rutabaga. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 4 days. Do not exceed 0.075 lb ai/a per season.
- acetamiprid (Assail 30SG) at 0.038 to 0.1 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.375 lb ai/a or four treatments per season. Turnip greens only.
- afidopyropen (Versys Inscalis) at 0.01 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per year. Turnip greens only.
- azadirachtin (Neemix 4.5) at 0.18 to 0.25 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol ESO) at 0.25 to 1 quart/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season. turnip greens only.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Limit 2 treatments.
- clothianidin (Belay) at 0.67 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 10 days. Do not exceed 0.2 lb ai/a per year. Turnip greens only.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- cyantraniliprole (Exirel) at 0.088 to 0.133 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year. Turnip greens only.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year. Turnip greens only.
- deltamethrin (Delta Gold) at 0.012 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- dimethoate (Dimethoate 400) at 0.25 lb ai/a. PHI 14 days. REI 48 hr. Retreatment interval 3 days. Do not exceed 1.75 lb ai/a per year. Turnip only.
- dinotefuran (Dinotefuran 20SG, Venom) at 0.088 to 0.131 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.262 lb ai/a per season. Turnip greens only.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.267 lb ai/a per season. Limit 3 applications. Retreatment interval 7 days.
- flupyradifurone (Sivanto 200SL) at 0.09 to 0.16 lb ai/a. PHI 1 day, turnip greens, 7 days roots. REI 4 hr. Retreatment interval 7 days for greens, 10 days for roots. Do not exceed 0.365 lb ai/a per season. Limit 3 treatments.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a, or 0.011 to 0.027 lb ai/1,000 row ft soil or 0.044 lb ai/a foliar. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a foliar or 0.38 lb ai/a soil per year.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/a per season.
- malathion (Fyfanon 8E) at 1 to 1.25 lb ai/a. PHI 1 day turnips, 7 days rutabagas. REI 12 hr. Retreatment interval 5 days for greens, 7 days for roots. Limit 3 treatments.
- permethrin (Loveland Permethrin) at 0.05 to 0.015 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.45 lb ai/a per season. Washington only. Turnip only.
- pymetrozine (Fulfill) at 0.086 lb ai/a. REI 12 hr. PHI 7 days. Retreatment interval 7 days. Do not exceed 0.172 lb ai/a per season. A penetrating adjuvant improves performance. Turnip greens only.
- sulfoxaflor (Transform WG) at 0.023 to 0.031 lb ai/a. PHI 7 day. REI 12 hr. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a at plant. REI 12 hr. Do not exceed 0.188 lb ai/a per season. See label for recommended in-row application instructions.

## Turnip (roots and tops) and rutabaga—Cabbage maggot

*Delia radicum*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Once the crop emerges, watch for wilting, lighter green or purpled plants, or reduced growth that may indicate a maggot infestation. Pull up affected plants, and check roots and soil to confirm the presence of maggots. If several rows of seedling plants are infested, plants may be removed and rows replanted. Drenching with insecticide is also an option, but such treatments are difficult, costly, and may not be adequate. If roots are tunneled but no maggots are present, maggots have left the roots to pupate, and insecticide treatments would be of little value. Sticky traps, bucket traps, and sweep nets also can be used to monitor the adult fly.

### Management—biological control

Rove beetles prey on eggs and young maggots. Rove larvae parasitize the pupa stage of the maggot. The parasitic wasp *Trybliographa rapae* lays its eggs in the maggot larvae if the larvae are close enough to the soil surface. Biological controls cannot be counted on to provide adequate control.

### Management—cultural control

Where maggots are a perennial problem, grow seedlings for transplants in fumigated soil in the greenhouse or under frames of clear plastic. Avoid hardening transplants near infested fields. Direct-seeded crops may avoid some injury if a set of drag chains, attached behind the planter, eliminates the moisture gradient in the seed row. It is believed that adult flies can locate the seed row for egg-laying by homing in on the higher moisture levels created when the soil is overturned for planting. Cover crops with floating row covers or screen cages prior to emergence of adult flies to prevent egg-laying. Do not put row covers in areas previously infested.

Older plants may outgrow moderate cabbage maggot populations if maintained with a careful irrigation schedule. Always disc under crop residues immediately after harvest. Maggots can survive for some time in crop residue. Do not follow susceptible crops with susceptible crops, unless sufficient time has passed for the residue to dry or decompose completely.

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chlorpyrifos (Lorsban Advanced) at 0.05 to 0.1 lb ai/1,000 row ft or 2.11 lb ai/a soil surface spray. PHI 30 days. REI 24 hr. Band and incor-

porate to 1 inch at planting, or side-dress immediately after transplanting. Use at least 40 gal/a spray. Do not exceed 2.25 lb ai/a per year. Apply only once per season.

- cyantraniliprole (Verimark) at 0.088 to 0.176 lb ai/a at planting only, as in in-furrow spray or transplant drench. PHI 1 day. REI 4 hr. Do not exceed 0.176 lb ai/a at planting. Do not exceed 0.4 lb ai/a per season.
- diazinon (Diazinon 50W) at 2 to 3 lb ai/a. Broadcast before planting. REI 4 days. Rutabagas only.

## Turnip (roots and tops) and rutabaga—Diamondback moth

*Plutella xylostella*

### Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Natural enemies and insecticides applied to control other pests keep the diamondback moth under satisfactory control in most fields, but keep records of diamondback moths as you monitor for other caterpillars. Adult moths frequently migrate from fields being harvested or disked.

### Management—biological control

Natural enemies, including an ichneumid wasp and the egg parasite *Trichogramma pretiosum*, often effectively control diamondback moth in California. Therefore, take into account the level of parasitism when making control decisions. Clearly, *Bt* is much easier on the beneficial insects, and its use, when needed, helps conserve the beneficial insect complex.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Do not use on rutabaga. Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- insecticidal soap (as a mix with spinosad)—May require several applications. Do not use on rutabaga. Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Acts slowly; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a product. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Exirel) at 0.045 to 0.088 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 6 treatments per year. Do not exceed 0.4 lb ai/a per year. Turnip greens only.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season. Turnip greens only.
- emamectin benzoate (Proclaim) at 0.008 to 0.015 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.09 lb ai/a per season. Turnip greens only.
- indoxacarb (Avaunt) at 0.065 lb ai/a. PHI 3 days. REI 12 hr. Do not exceed 0.26 lb ai/a per crop. Retreatment interval 3 days. Turnip greens only.
- GS-omega/kappa-Htx-Hv1a (Spear Lep) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- methomyl (Lannate SP) at 0.45 to 0.9 lb ai/a. PHI 10 days. REI 48 hr. Turnip greens only. Do not exceed 3.6 lb ai/a per season.
- permethrin (Loveland Permethrin) at 0.05 to 0.15 lb ai/a. PHI 1 day. REI 12 hr. Do not exceed 0.45 lb ai/a per season. Turnip only.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 3 days. Retreatment interval 7 days. Do not exceed 0.266 lb ai/a per season. Limit 6 treatments per season. Turnip greens only. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.023 to 0.047 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 5 days. Do not exceed 0.45 lb ai/a per season. An adjuvant improves control. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

## Turnip (roots and tops) and rutabaga—Flea beetle

Includes *Phyllotreta cruciferae*

## Pest description, crop damage and life history

See:

Common Pests of Vegetable Crops

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours. Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 ft of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

### Management—cultural control

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin
- carbaryl
- cyfluthrin
- imidacloprid
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.075 lb ai/a per season.
- beta-cyfluthrin (Baythroid XL) at 0.019 to 0.025 lb ai/a. PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a per season. Turnip greens only.
- beta-cyfluthrin/imidacloprid (Leverage 360) at 0.07 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.1 lb ai/a beta-cyfluthrin or 0.2 lb ai/a imidacloprid per season. Turnip greens only.
- bifenthrin (Brigade WSB) at 0.08 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.5 lb ai/a per season. Retreatment interval 7 days.
- bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.06 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 21 days. Do not exceed 0.45 lb ai/a per season. Limit 2 treatments.
- carbaryl (Sevin 4F) at 0.5 to 1 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 6 lb ai/a per season.
- cyfluthrin (Tombstone) at 0.038 to 0.05 lb ai/a (roots). PHI 0 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai/a per season. Turnip greens only.
- cyfluthrin/imidacloprid (Leverage 2.7) at 0.08 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.17 lb ai/a cyfluthrin or 0.24 lb ai/a imidacloprid per year. Turnip greens only.
- deltamethrin (Delta Gold) at 0.018 to 0.028 lb ai/a. PHI 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.14 lb ai/a per season.
- dinotefuran (Dinotefuran 20SG, Venom) at 0.088 to 0.131 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.262 lb ai/a per season. Turnip greens only.
- esfenvalerate (Asana XL) at 0.03 to 0.05. PHI 7 days. REI 12 hr. Do not exceed 0.4 lb ai/a per season. Turnip only.
- imidacloprid (Admire Pro) at 0.16 to 0.38 lb ai/a, or 0.011 to 0.027 lb ai/1,000 row ft soil or 0.044 lb ai/a foliar. PHI 7 days foliar, 21 days soil. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.13 lb ai/a foliar or 0.38 lb ai/a soil per year.
- imidacloprid (Provado, Prey) at 0.044 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.23 lb ai/a per season.
- malathion (Fyfanon 8E) at 1.25 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 5 days. Limit 3 treatments Turnips only.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.28 lb ai/a per season. Retreatment interval 5 days. Entrust SC is OMRI-listed for organic use.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/a per season.
- thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a at plant. REI 12 hr. Do not exceed 0.188 lb ai/a per season.
- zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.3 lb ai/a per year.

## Turnip (roots and tops) and rutabaga—Wireworm

**Includes** *Ctenicera* spp.

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

### Management—biological, cultural, tactical

*See:*

Potato, Irish—Wireworm

### Management—chemical control: HOME USE

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin).
- cyfluthrin
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

- chloropicrin (Telone)—Preplant.
- chlorpyrifos (Lorsban Advanced) at 2.11 lb ai/a soil surface spray. PHI 30 days. REI 24 hr. Use at least 40 gal/a spray. Do not exceed 2.25 lb ai/a per year. Apply only once per season.

## Watercress—Aphid

**Includes** bean aphid (*Aphis fabae*)

**Pest description and crop damage** The bean aphid is dark olive green to black with light-color legs. It is usually more of an early-year pest. Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth; and spreading plant diseases. Infestations frequently are localized; heavily infested leaves curl down.

### Management—chemical control: HOME USE

Apply to both tops and undersides of leaves.

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- imidacloprid
- Insecticidal soap (as a mix with spinosad)—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (sesame, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/a. PHI 0 days. REI 4 hr.
- imidacloprid (Admire) at 0.16 to 0.38 lb ai/a soil or 0.047 lb ai/a foliar. PHI 21 days soil; 7 days foliar. REI 12 hr. Do not exceed 0.38 lb ai/a soil or 0.24 lb ai/a foliar per season.
- imidacloprid (Provado, Prey) at 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- insecticidal soap (M-Pede) at 1% to 2% solution. See label for gal/a. PHI 0 days. REI 12 hr.
- malathion (Malathion 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 3 days. Limit 5 treatments.
- pyrifluquinazon (PQZ Insecticide) at 0.035 to 0.047 lb ai/a. PHI 1 day. REI 12 hr. Limit 6 treatments. Retreatment interval 7 days. Do not exceed 0.21 lb ai/a per year. Apply by ground equipment. Fields must be drained prior to application.
- tolfenpyrad (Torac) at 0.17 to 0.21 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 14 days. Limit 4 treatments per year. Do not exceed 0.42 lb ai/a per year.

## Watercress—Flea beetle

**Includes** cabbage flea beetle (*Phyllotreta cruciferae*)

### Pest description, crop damage and life history

*See:*

Common Pests of Vegetable Crops

**Biology and life history** Most flea beetle species have similar life cycles. Adults overwinter in trash around field margins. They become active in

late March through May. Flea beetles lay their very small eggs in May in the soil around the plant, on the leaves, or in cavities hollowed out in stems. The larvae feed on the foliage, mine the leaves, or attack the roots, depending on the species, usually from June to mid July, when pupation in the soil occurs. Adults emerge from July through early September and feed a short time before overwintering in trash around field margins. Depending on the species, there are one or two generations each year.

**Pest monitoring** Monitor fields for flea beetles soon after transplanting or as seedlings emerge. Flea beetles attacking the cotyledons of emerging broccoli seedlings can destroy a new planting in 24 hours. Treat for flea beetles when small holes show on transplants or on plants from seeded fields. Young plants (three to five leaves) often withstand flea beetle injury, but they may be killed if the weather is dry and windy. The percentage of plants affected and forecasted weather conditions will indicate the need to treat.

When the flea beetles on seedlings are migrating from hosts outside of the field, most of the infestation will be localized within 200 feet of field borders. Check the distribution of leaf feeding to see if this is the case, and consider border treatments only. If high populations exist 1 to 2 weeks before harvest, and foliage is declining as a food source for the beetles, spot treat according to the flea beetle distribution.

#### **Management—cultural control**

“Trap crops” such as radish or daikon may help lure flea beetles away from the main crop. This has not been tested in the Pacific Northwest. Floating row covers or other screening can be used to exclude the beetles during seedling establishment of high-value crops. Flea beetles can be vacuumed off foliage, but this must be repeated frequently. Reinvasion of plants can be rapid.

#### **Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- imidacloprid
- kaolin—Applied as a spray to foliage, It acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- dinotefuran (Dinotefuran 20SG, Scorpion 35SG) at 0.09 to 0.18 lb ai/a. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.36 lb ai/a per season.
- malathion (Malathion 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 3 days. Limit 5 treatments.

## **Watercress—Lepidoptera larvae**

#### **Includes**

Beet armyworm (*Spodoptera exigua*)  
Cabbage looper (*Trichoplusia ni*)  
Diamondback moth (*Plutella xylostella*)  
Imported cabbageworm (*Pieris rapae*)

#### **Pest description, crop damage and life history**

*See:*

Common Pests of Vegetable Crops

#### **Management—chemical control: HOME USE**

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- insecticidal soap (as a mix with spinosad)—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, It acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

- *Bacillus thuringiensis* (Javelin) at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Slow acting; may need multiple applications. Add an appropriate spreader-sticker to enhance control. Most effective on small larvae. Some formulations are OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/a. PHI 0 day. REI 4 hr.
- GS-omega/kappa-Hv1a (Spear Lep) at 1 to 2 pints/a. PHI 0 days. REI 4 hr.
- imidacloprid (Provado, Prey) at 0.047 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 5 days. Do not exceed 0.24 lb ai/a per season.
- spinetoram (Radiant SC) at 0.039 to 0.078 lb ai/a. PHI 1 day. Retreatment interval 4 days. Do not exceed 0.266 lb ai/a per year. Limit 6 treatments per season. Do not apply to seedling leafy vegetables grown for transplant within a greenhouse, shade house, or field plot.
- spinosad (Success, Entrust SC) at 0.023 to 0.125 lb ai/a. PHI 1 day. REI 4 hr. Do not exceed three applications within 21 days. Do not exceed 0.45 lb ai/a per season. Entrust SC is OMRI-listed for organic use.

## **Watermelon—see Melon**

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# Irish Potato Pests

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## ***INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE***

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In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making *any* pesticide applications.

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It is essential to consult pesticide labels for rates, timings, safety precautions, plant-back restrictions, etc. prior to making a recommendation or deciding on a treatment program. The following websites offer searchable databases of products, including which pests and crops are on their labels. These web resources allow thorough research on pesticide products prior to making recommendations or treatment decisions.

<https://picol.cahnrs.wsu.edu/>—This is a database of all pesticides registered in Washington and Oregon.

<https://www.cdms.net/LabelsSDS/home/>

<https://home.agrian.com/label-lookup/>

For general information on potato insect pests, see the following.

1. <https://www.nwpotatoresearch.com/>
2. <https://pnwpest.org/potato/>
3. <https://cdn.intechopen.com/pdfs/28267.pdf>
4. [https://link.springer.com/chapter/10.1007/978-3-030-39157-7\\_11](https://link.springer.com/chapter/10.1007/978-3-030-39157-7_11)

## **Special Note about Resistance Management and Secondary Pest Outbreaks**

At least three of the important pests of potato are known worldwide for developing resistance to insecticides. Of particular concern are green peach aphid (*Myzus persicae*), Colorado potato beetle (*Leptinotarsa decemlineata*), and potato tuberworm (*Phthorimaea operculella*). To prevent further development of insecticide-resistant pest populations, it is important that growers do not rely on single mode of action through a season. Of particular concern is the class of insecticides known as neonicotinoids (Group 4A in Tables 1-2 of this section). These are highly effective insecticides that can control many pests of potato all season long. However, resistance to this class of chemicals has developed in Colorado potato beetle in other parts of the U.S., and care must be taken to avoid the development of resistance in the PNW. If used at planting or as a seed treatment, neonicotinoid products should not be used again as a foliar treatment. Always avoid treating large contiguous areas with any single class of chemistry.

Pyrethroid insecticide (Group 3 in Tables 1-2) applications may make pest management more difficult by leading to outbreaks of aphids, thrips, and spider mites.

**Note:** Products are listed in alphabetical order and not in order of preference or superiority of pest control.

## **Potato, Irish—Aphid**

### **Includes**

Green peach aphid (*Myzus persicae*)

Potato aphid (*Macrosiphum euphorbiae*)

**Note:** Over 30 species of aphids can be found in potato fields; many are considered non-colonizing.

**Pest description and crop damage** Aphids are soft-bodied insects with a pair of abdominal cornicles that exude sugary droplets. Green peach aphid and potato aphids are the two most common aphid species in potato. Potato aphid is more common in the spring and fall, while green peach aphid peaks during July and early August. Large populations of aphids can cause yield reductions through direct feeding, but their principal economic impact is due to their ability to transmit plant viruses such as potato leaf roll virus (PLRV) and potato virus Y (PVY).

PLRV (Luteoviridae: Polerovirus) causes tuber symptoms in some varieties called tuber net necrosis. This internal tuber discoloration is not acceptable in the marketplace. Foliar symptoms occur in younger leaves where leaf margins become necrotic, turning brown and purplish, and curl inwards. PLRV is transmitted in a persistent manner, meaning that an aphid that has acquired the virus can transmit it to uninfected plants for the rest of its life. Persistent viruses require a latent period within the aphid before they can be transmitted. The low tolerance in the marketplace for net necrosis, and the high vectoring capacity of green peach aphid, means there is a very low treatment threshold for this pest. PLRV has not been a substantial problem since neonicotinoids have been used in potatoes.

Potato virus Y (PVY) (Potyviridae: Potyvirus) is a serious disease in potato production in the PNW. New strains of PVY that cause transient foliar symptoms with internal brown lesions in tubers are becoming common. This damage is unacceptable in the marketplace. PVY is transmitted by many different aphid species in a non-persistent manner, which means that aphids probing an infected potato plant acquire the virus, then when moving to a non-infected plant, they inoculate it mechanically with the virus. There is no latent period. PVY is transmitted very quickly—in a far shorter time than most insecticides can act to prevent aphid feeding. This, and the fact that most PVY transmission is by non-colonizing aphids (those that do not live in the potato field), means that PVY control with insecticides is poor at best.

**Biology and life history** Winged green peach aphids arrive on potatoes in the spring from weeds and various crops where they overwintered as nymphs and adults. Potato aphids overwinter as nymphs, adults, or eggs; eggs are laid on roses and other plants. Both species feed on many crops, weeds, and native plants. Throughout the growing season, aphids produce live young, all of which are female and can be either winged or wingless. Winged aphids tend to be produced more when colonies become crowded. In the fall, winged males are produced which fly to overwintering hosts and mate with egg-laying females produced on that host. Both species of aphids found on PNW potatoes undergo multiple overlapping generations per year.

**Scouting and thresholds** Fields should be checked for aphids at least weekly starting shortly after potato emergence. When plants are upright, the most effective scouting method is to shake plants above beating sheets, beating trays, or half gallon ice cream buckets. In some varieties, the vines become very long, lie down on the soil, and become intertwined, making beating sheets or buckets difficult to use. In this case, a leaf sampling scheme might be useful. Field scouts can also use a bucket trapping technique ([https://aphidtrek.org/?page\\_id=1295](https://aphidtrek.org/?page_id=1295)). There are no well-established treatment thresholds for aphids on potato in the PNW, however seed potato fields require a particularly low treatment threshold.

#### **Management—biological control**

Potatoes can harbor large numbers of generalist predators that feed on aphids. These include the Hemipteran bugs: *Orius* pirate bug, *Geocoris* big-eyed bug, and *Nabis* damsel bug. Other common aphid predators include lady beetles and their larvae, lacewings, and flower fly larvae. Aphid-specific parasitoid wasps can also be common in potato fields that are not heavily treated with insecticides.

#### **Management—cultural control**

The most important source of virus in a potato field is infected potato plants. Therefore, purchasing certified seed with low or no virus infection is the best first step in controlling aphid-related damage to potatoes. Controlling other sources of virus inoculum such as cull piles and volunteer potatoes is also important.

#### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—As a spray to foliage and stems it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- plant essential oils (clove, garlic, rosemary etc.)—Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

When used to control other pests, pyrethroid (Group 3 in Tables 1-2) applications make aphid management more *difficult*. Pyrethroids eliminate aphid predators and parasitoids which naturally control pests in the field. Data show that early applications of pyrethroids cause flare-ups of not only aphids, but other pests such as mites and thrips. When possible, it is best to use aphid insecticides with narrow spectra of control and avoid package mixes (Table 2) and other products that kill beneficials.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Armyworm and cutworm

### Includes:

Bertha armyworm (*Mamestra configurata*)  
Spotted cutworm (*Xestia c-nigrum*)

**Pest description and crop damage** Several species of moth caterpillars (Order Lepidoptera) of various colors can sometimes be found in potatoes, but the most important in the PNW are bertha armyworm, spotted cutworm, and cabbage looper (see separate looper section, below). Armyworms and cutworms have three pairs of true legs in the front, and five pairs of pro-legs behind. Damage to mature potato plants is usually minor, and these caterpillars usually do not require control.

**Biology and life history** Armyworms and cutworms feed on foliage at various times of the season depending on which species is involved. Some species overwinter as medium-sized larvae and can extensively damage small plants early in the season. Some cutworms are active mostly at night and therefore are difficult to sample and monitor.

**Scouting and thresholds** The first thing usually noticed during an infestation of defoliating caterpillars is holes in leaves, with infestations starting in early summer. It is important that caterpillars are found before any control measures are implemented. When plants are upright, caterpillars can easily be found during beating sheet/tray sampling for aphids. There are no established treatment thresholds for defoliating caterpillars in potatoes. However, knowing that only a few species have potential to be important as potato pests offers the chance to deploy specific monitoring tools such as pheromone-baited traps for adults. There are effective pheromone lures for both spotted cutworm (z7-tetradecenyl acetate) and bertha armyworm (z9-tetradecen-1-ol acetate and z11-hexadecen-1-ol), both commercially available.

### Management—biological control

These caterpillars are prey of most generalist predators in potato fields, including *Geocoris* big-eyed bugs, *Nabis* damsel bugs, and probably various species of ground beetles (Carabidae) and rove beetles (Staphylinidae) that are known to inhabit potato fields. They are also commonly attacked by various pathogens, parasitoids, and birds.

### Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (often as a mix with zeta-cypermethrin)
- carbaryl
- cyfluthrin
- deltamethrin
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (peppermint, rosemary, etc.)—Some have demonstrated efficacy against Lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

See:

Pesticide Tables for Potato Pests

## Potato, Irish—Blister beetle

### Includes

*Epicauta* spp.

**Pest description and crop damage** Adults feed on the leaves, causing a ragged appearance. Adults are 0.5 inch long, gray to black, with narrow and elongate bodies and conspicuous heads and necks. The pronotum (the segment that covers part of the thorax), when viewed from above, is narrower than either the head or abdomen. Larval blister beetles live in the soil in uncultivated land and are predators of grasshopper and bee eggs, thus they are more prevalent next to natural areas and fallow fields. Adults feed on the foliage of many different plants. Occasionally, these beetles can cause complete defoliation of affected areas, but because they are extremely clumped within a field, little total damage normally results.

### Management—chemical control: HOME USE

If control is required, only spot treatments may be needed.

For more information, see [https://s3.wp.wsu.edu/uploads/sites/2071/2013/07/Blister-Beetles\\_FS113E.pdf](https://s3.wp.wsu.edu/uploads/sites/2071/2013/07/Blister-Beetles_FS113E.pdf)

- azadirachtin (as a mix with other active ingredients)—Some formulations are OMRI-listed for organic use.
- carbaryl
- deltamethrin
- malathion
- pyrethrins (often as a mix with sulfurs)—Some formulations are OMRI-listed for organic use.

- zeta-cypermethin

**Note:** Pyrethroid insecticide (Group 3 in Tables 1-2) applications can lead to outbreaks of aphids, thrips, and spider mites.

**Management—chemical control: COMMERCIAL USE**

Chemical control of blister beetles in potatoes is rarely required, and spot treatment of affected portions of a field is effective. There are no known economic thresholds for blister beetle management.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Colorado potato beetle

*Leptinotarsa decemlineata*

**Pest description and crop damage** The Colorado potato beetle (CPB) is a yellow and black striped beetle, about 0.5 inch long and 0.25 inch wide. Larvae are reddish orange, with two rows of black spots on each side. They lay yellow egg clusters, usually on the underside of leaves. Adult and larvae can cause complete defoliation and nearly complete crop loss if allowed to reproduce unchecked. Larvae are more voracious than adults and can eat up to 40 sq cm of leaves or green tissue.

**Biology and life history** Both larvae and adults feed on potato foliage through the season. Pupation occurs in the soil. Adults overwinter in the soil, emerging to feed, lay eggs, and mate in the spring. In cool climates, the beetle undergoes only one generation per season, but in warmer areas, such as the southern Columbia Basin, it may have up to three generations. Other host plants of CPB include solanaceous weeds such as nightshade, and crops such as tomato and eggplant. Sometimes they can be seen in puncture vine although we do not know if they are looking for complementary nutrient sources or if it is a sporadic event. In 2020, they were observed in large numbers feeding on hemp.

**Scouting and thresholds** Check fields for CPB starting at crop emergence: beetles are easily spotted when plants are small. Because larvae feed toward the tops of the plants, scouting for this insect is easily done as workers walk through fields. There are no established treatment thresholds for CPB. The goal of management should be to limit population growth and spread through fields and farms: large populations are harder to manage than small ones. Usually, damage starts around the border of the fields since adults tend to walk rather than fly. CPB can completely defoliate potato plants if left uncontrolled.

**Management—biological control**

This insect is unpalatable to some generalist predators, but eggs and young larvae are fed upon by *Geocoris* big-eyed bugs and Nabis damsel bugs. There are also two large predatory stink bug species that feed on CPB larvae and at least one species of beneficial fly of the genus *Myiopharus* (previously known as *Doryphorophaga*) that attacks CPB. Birds such as crows are also good predators of CPB. In some situations, severe disease-related mortality can occur during pupation and overwintering in the soil, although this is rare in dry conditions.

**Management—cultural control**

Crop rotation is very important for CPB management. Adults overwinter in the soil, so if potatoes follow potatoes, beetles will emerge and immediately infest the new crop. Some studies suggest at least 0.5 km distance between fields to provide protection when crops are rotated. Trenches are also recommended since the beetles disperse from their overwintering sites by walking. Trap crops are also recommended.

**Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap (as a mix with other active ingredients)—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

The CPB has developed high levels of resistance to insecticides in many parts of the country. Populations in the PNW are still susceptible to most labeled products. The lessons learned by potato growers in the eastern U.S. should still be heeded here:

1. CPB can develop high levels of resistance to almost all classes of chemicals.
2. Carefully rotating insecticidal modes of action is critical to slow the development of resistance. Tables 1-3 show insecticide modes of action.
3. Use recommended label rates.

In many parts of the PNW, chemical control of CPB is necessary to avoid catastrophic build-up of populations. A standard practice is the use of

neonicotinoids at planting. Generally, insecticides should not be applied until egg hatch begins. Border sprays are sometimes an economical choice, especially early in the season before populations build up.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

**Pest description and crop damage** Larvae may feed on tubers in potato fields west of the Cascade Mountains. Adults are 0.33 inches long, yellowish green, with distinct black spots on the wing covers. Mature larvae are about 0.33 inches long and white with brown on both ends. Adults feed on leaves and stems.

### Management—chemical control: HOME USE

Apply when beetles first appear and repeat at 7- to 10-day intervals as needed.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Flea beetle

Tobacco flea beetle (*Epitrix hirtipennis*)

Tuber flea beetle (*Epitrix tuberis*)

Western potato flea beetle (*Epitrix subcrinata*)

**Pest description and crop damage** Three species of flea beetles—the tobacco flea beetle (*E. hirtipennis*), the tuber flea beetle (*E. tuberis*), and the western potato flea beetle (*E. subcrinata*)—are known foliage feeders in PNW potato fields, especially west of the Cascades. Of these, only the tuber flea beetle seriously injures potato tubers.

All three species have yellowish-brown legs. The tuber flea beetle tends to be dull black, whereas in bright light the western potato flea beetle has a distinct bronze luster. The tobacco flea beetle tends to be brownish in color with a darker brown to black irregular band across the elytra. It is not unusual to find flea beetles of the genus *Phyllotreta* in potato fields feeding on various weeds. The flea beetles that do not feed on potatoes have black legs.

Oregon surveys indicate that only the western potato flea beetle is in potato fields of Malheur, Baker, and Klamath counties. Although once in heavy numbers in Deschutes, Crook, and Jefferson counties, the tuber flea beetle has not recently been a problem in these areas. West of the Cascades, tuber flea beetle is a serious problem in some areas, particularly the Skagit Valley of Washington.

The damage to potato tubers by the tuber flea beetle is almost identical to that of symphylans. Both tuber flea beetles and symphylans sometimes live in the same field. Adults chew minute circular holes on the leaves producing shot-holes pattern. Larvae feeding damage to tubers consists of shallow subsurface wavy furrows.

**Biology and life history** Tuber flea beetle adults overwinter buried in the soil in and around potato fields. Overwinter survival appears to be highest in elevated, wet grassy headland regions unaffected by field flooding. There are two to three generations annually in growing areas west of the Cascade Mountains, which are the areas primarily affected by flea beetles. The first generation begins with the overwintered adult flight from late May to late June. Mating and egg laying can continue for up to a month. Generally, the larval stage takes about three weeks to complete, followed by a two-week pupation period. First generation larvae feed from early June to mid-July, second generation from mid-July to mid-August, and third generation from mid-August to mid-September. The second and third generation larval damage is of particular importance to the late crop potato varieties. The life cycle normally is completed in about 6 weeks.

### Management—biological control

The soil-dwelling larvae are likely affected by nematode parasites and fungal diseases, as well as predatory beetles such as ground and rove beetles.

The active adult stage is likely most affected by spiders.

#### **Management—chemical control: HOME USE**

Apply in late May when beetles appear on foliage, directing treatment where stems of potato vines enter soil. No tuber treatments against flea beetles are available for home garden vegetables.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap (as a mix with pyrethrins)—Some formulations are OMRI-listed.
- malathion
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (peppermint, rosemary, etc.)—Some have demonstrated efficacy against Lepidopteran larvae. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

Foliar insecticide applications are recommended for control of the tuber flea beetle. This type of control is directed against the adult beetles, killing them before they can deposit eggs. Soil applied insecticides and seed treatment products are also available to control both larvae and adults of flea beetles. A number of chemicals are registered for controlling this beetle on potato (See Tables 1-2).

If needed, the initial foliar application usually is when 50 to 66% of potato plants have emerged. Applications should be repeated weekly or at 10 day intervals, or when adult beetles reach or exceed 10 beetles per 50 sweeps of a standard 15-inch sweep net. In the Willamette Valley, observations indicate that sweep samples may be unreliable for potatoes just emerging through the ground. As few as two beetles per 25 sweeps on borders of fields of young, emerging potatoes may be an economic infestation. Occasionally, border sprays may be all that is necessary on just-emerging potatoes. Flea beetles can become a severe problem in second-year fields; therefore, crop rotation is encouraged.

**Note:** Pyrethroid insecticide (Group 3 in Tables 1-2) applications make aphid management more difficult and can lead to outbreaks of aphids, thrips and spider mites.

*See:*

Pesticide Tables for Potato Pests

## **Potato, Irish—Garden symphylan**

*Scutigera immaculata*

**Pest description and crop damage** The garden symphylan (Myriapoda) is a small, white, centipede-like animal in the soil. This arthropod is a pest of potatoes in isolated pockets in the PNW, especially west of the Cascade Mountains. Damage consists of scars on the tuber skin, which are undesirable in the marketplace. Because damage from symphylans and flea beetles is very similar, it is important to be sure that symphylans are present prior to any treatments aimed at their control. The symphylan is an important pest in several vegetable and seed crops west of the Cascade.

*See:*

Biology and Control of the Garden Symphylan

#### **Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- pyrethrins—Some formulations are OMRI-listed for organic use.

#### **Management—chemical control: COMMERCIAL USE**

*See:*

Pesticide Tables for Potato Pests

## **Potato, Irish—Grasshopper**

### **Includes**

Spotted winged grasshopper (*Orphulella pelidna*)

**Pest description and crop damage** Many different grasshopper species live in areas near or where potatoes are grown, and most of these could occasionally feed on potatoes. A similar insect that sometimes invades and damages potato fields is the Mormon cricket (*Anabrus simplex*), which is

actually a flightless katydid.

*See also:*

Hay and Pasture Crops

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant essential oils (rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

Grasshoppers require control on potatoes only in the most extreme outbreak years or locations.

*See:*

Pesticide Tables for Potato Pests

## **Potato, Irish—Leafhopper**

Beet leafhopper (*Circulifer tenellus*)

Other leafhoppers (*Empoasca* spp., *Ceratagallia* spp.)

**Pest description and crop damage** The most important leafhopper for potato producers in the PNW is the beet leafhopper, due to its ability to transmit the beet leafhopper transmitted virescence agent (BLTVA) phytoplasma. This leafhopper varies in color but is always one of the smaller species and lacks prominent spots or other dorsal or head markings. Phytoplasmas can cause a wide range of symptoms in potatoes that are collectively referred to as “purple top,” including leaf curling and purpling, aerial tubers, chlorosis, and early senescence. Beet leafhopper is the only known vector of BLTVA in the Columbia Basin of Oregon and Washington. Most BLTVA infection occurs early in the season, during May and June, although some evidence suggests damaging infections in July.

A wide diversity of leafhoppers can be found in potato fields. At least one species of *Empoasca* reproduces on potatoes in the PNW. These leafhoppers are small, pale green, and torpedo-shaped. They hold their wings roof-like over the body at rest. *Empoasca* leafhoppers are rarely found in significant numbers in the PNW. Other leafhoppers usually do not reproduce in potato fields but are present in large numbers like *Ceratagallia* spp.

**Biology and life history** The beet leafhopper overwinters as adult females in weedy and native vegetation, mainly from the mustard family, throughout most of the dry production areas east of the Cascade Mountains. Eggs are laid in stems of host plants, and a new spring generation begins developing in March and April. Beet leafhoppers begin to move and potentially affect potatoes during the first spring generation, which matures in late May to early June. Newly emerged adults in each generation tend to migrate from their birth areas to new areas, which causes them to encounter crop fields and potentially transmit BLTVA. Not all beet leafhoppers feeding on BLTVA-infected plants carry the disease, making management challenging. Also, early beet leafhopper infestation can reduce yield and quality. Potatoes are most seriously affected by BLTVA infections that occur early in the growing season. Beet leafhoppers can remain common through the summer, during which it goes through 2 to 3 overlapping generations. The final generation for the year matures during late October and can sometimes be the largest of the year. The favorite hosts of the beet leafhopper appear to be kochia, Russian thistle, and various weedy mustard species such as tumble mustard. It seems to thrive best in marginal unirrigated situations where its host plants are small and under stress.

**Scouting and thresholds** For detailed information on monitoring beet leafhoppers using yellow sticky traps, see: [https://nwpotatoresearch.com/pdfs/PotatoProgressVIII\(2\).pdf](https://nwpotatoresearch.com/pdfs/PotatoProgressVIII(2).pdf)

#### **Management—biological control**

Beet leafhoppers are preyed upon by a specific parasitoid in the fly family Pipunculidae. In potato fields, where beet leafhoppers occur almost exclusively as adults, the most likely biocontrol agents are the many species of spiders that commonly live in crops.

#### **Management—cultural control**

Controlling the favorite weed hosts of beet leafhopper is probably the most important cultural management option. Indications are that beet leafhoppers within several hundred feet of a potato field may be most important in BLTVA transmission. Therefore, controlling beet leafhopper’s favorite weed hosts near potato fields may reduce BLTVA incidence.

### **Management—chemical control: HOME USE**

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- plant essential oils (garlic, peppermint, rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- spinosad (as a mix with insecticidal soap)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

More information related to the biology and management of beet leafhoppers can be found at <https://catalog.extension.oregonstate.edu/em9282>

### **Management—chemical control: COMMERCIAL USE**

The most important time to control leafhoppers that transmit BLTVA is early in the season—probably the first two months after emergence. Frequent applications may be necessary since the beet leafhopper vector is only a transient visitor to potato fields. One spray may kill the leafhoppers in the field as well as new invaders for a residual period, but more leafhoppers will invade from surrounding areas throughout the season.

**Note:** Pyrethroid insecticide (Group 3 in Tables 1-2) applications make beet leafhopper management more difficult and can lead to outbreaks of aphids, thrips, and spider mites.

*See:*

Pesticide Tables for Potato Pests

## **Potato, Irish—Leatherjacket**

Large crane fly (*Tipula dorsimacula Walker*)

**Pest description and crop damage** Larvae are about 1.5 inches long, gray or gray-brown, and wormlike. The head is retractable into the body, and there are no legs. Larvae are common from late July through September. They feed on tubers and cause punctures varying from shallow depressions to deeper holes. The adult is a thinly built fly about 1 inch long, resembling a giant mosquito with an orange and black abdomen without evident mouth parts.

### **Management—cultural control**

This pest most commonly causes problems in potato fields that are planted into spring-incorporated alfalfa residue. The best way to address leatherjacket problems is to avoid planting potatoes after alfalfa.

### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### **Management—chemical control: COMMERCIAL USE**

No products are registered.

## **Potato, Irish—Looper**

### **Includes**

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

**Pest description and crop damage** Larvae of both looper species appear as green caterpillars with white longitudinal stripes, three pair of true legs in front, and three pair of pro-legs behind. They move in a looping fashion, like an inchworm. Loopers chew holes and ragged edges in potato leaves. Potatoes can tolerate some looper defoliation without loss in marketable yield. The period of full bloom is the most sensitive plant growth stage, but even then, defoliation on the order of 10% appears to cause little if any yield loss.

**Biology and life history** Research has shown that cabbage looper is the only looper to develop well and regularly feed on potatoes in Oregon and Washington. It also has a tremendously fast developmental rate on potatoes, making it a pest with greater damage potential than other caterpillars. This moth has several overlapping generations each year, with moths found from May through September.

**Scouting and thresholds** Unlike cutworms and armyworms, loopers remain on the foliage all day long and are found easily during normal scouting operations using a beating sheet/tray. Nonetheless, the most obvious evidence of a looper infestation will be the feeding damage on the leaves and frass left behind. It is critical to confirm the presence of loopers on the foliage before treating – often the larvae are fully developed and either pupated or transformed to adult before damage is noticed.

#### **Management—biological control**

Cabbage looper populations can be severely impacted by various predators, parasitoids, and pathogens. For example, the disease caused by the nuclear polyhedrosis virus can spread rapidly in a population under certain conditions. Loopers dying from this disease often become limp, dark and blotchy, hanging in the foliage by their prolegs, and then burst, dripping virus-laden fluids onto the foliage which infects other loopers.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin)
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- plant essential oils (garlic, peppermint, rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

#### **Management—chemical control: COMMERCIAL USE**

Loopers are easier to control with insecticides when they are small.

*See:*

Pesticide Tables for Potato Pests

## **Potato, Irish—Lygus bug**

**Includes** tarnished plant bug (*Lygus hesperus*, *L. elysus*, *L. keltoni*)

**Pest description and crop damage** Adults are less than 0.25 inch long and marked with a “V” shaped or triangular mark on the back. Color ranges from light green to shades of brown or black. Nymphs are 0.04 to 0.25 inch in length, green or yellow-green, with black spots on the back. Adults and nymphs damage plants by inserting their mouth parts into the plant tissue and sucking juices. Lygus are considered “cell feeders”. Damage symptoms include flagging of leaflets, leaves, or small stems; damaged leaves wilt and the branch dies. Adults and nymphs prefer to feed on the top third of the plant canopy.

**Biology and life history** *Lygus* species, such as the tarnished plant bug, feed on many different plants including weeds, crops, and native species. Alfalfa and quinoa fields often develop very large populations of lygus from which the insects may colonize potato. Lygus can be found throughout the growing season and are common throughout the PNW. There are usually three or four generations each year. For more information, see <https://catalog.extension.oregonstate.edu/em9173>.

**Scouting and thresholds** Lygus are easily found during normal scouting operations using a beating sheet/tray technique/inverted leaf blower or observing insect activity while walking through the crop. Both adults and nymphs of all sizes are likely to be present at the same time. There are no established treatment thresholds for lygus in potatoes.

#### **Management—biological control**

Generalist predators in potatoes such as *Geogoris*, big-eyed bugs, and *Nabis*, damsel bugs, are known to prey on lygus adults and nymphs. There are also braconid wasp parasitoids attacking lygus in the PNW.

#### **Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations OMRI-listed.
- carbaryl
- cyfluthrin
- deltamethrin

- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (garlic, peppermint, rosemary, etc.)—Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pyrethroid insecticide (Group 3 in Tables 1-2) applications make aphid management more difficult and can lead to outbreaks of aphids, thrips, and spider mites.

**Management—chemical control: COMMERCIAL USE**

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Psyllid

Potato/tomato psyllid (*Bactericera cockerelli*)

**Pest description and crop damage** Adult psyllids resemble miniature cicadas, while the immature stages are scale-like and mostly sedentary, much more so than aphids, and look like white fly nymphs. Feeding by immature stages sometimes causes a physiological foliage disorder known as “psyllid yellows” in potatoes. Symptoms of psyllid yellows are very similar to those caused by phytoplasmas transmitted by leafhoppers.

*See:*

Potato, Irish—Leafhopper

No laboratory test can confirm psyllid yellows; rather, symptomatic plants that test negative for phytoplasmas often are assumed to have psyllid yellows. Potato psyllid transmits a bacteria-like organism (*Candidatus Liberibacter solanacearum*) that causes a syndrome called “zebra chip” (ZC), named after the characteristic discoloring of the tuber flesh in affected plants. This disease has been most severe in the Southwest U.S. and in Mexico, Central America, Ecuador, Australia and New Zealand. In 2011, this disease was found for the first time in many potato fields in Oregon, Washington, and Idaho. It appears that ZC is now an annual pest issue for PNW potato growers, but its severity may vary substantially between years.

**Biology and life history** The potato psyllid (western and northwestern haplotypes) is normally found in potatoes east of the Cascade Mountains beginning in early June. It is known to overwinter in many growing regions of the PNW, in association with bittersweet nightshade (*Solanum dulcamara*), morning glory (*Ipomoea violacea*), and related weeds. It may also migrate from more distant areas. Because of its late arrival in the crop, potato psyllid is rarely a direct pest in PNW potatoes, but the damage caused by ZC in 2011 showed that the PNW potato industry should be vigilant for early and severe psyllid populations each year. The ZC pathogen is acquired by psyllids during feeding, and once infected a psyllid can remain infective throughout its life, and females can transmit it to their offspring via eggs. Most psyllid populations have a low infection rate – far below 10%, with a range of 1-2% being more typical. For more information, see <https://catalog.extension.oregonstate.edu/pnw633>.

**Scouting and thresholds** The most commonly used scouting method for psyllids is yellow sticky traps. Psyllid adults are active flyers and are attracted to yellow, but traps must be placed 5-10 feet inside crop fields. This differs from monitoring beet leafhoppers, which feed and reproduce outside potato fields. To scout beet leafhoppers, it is recommended that sticky cards be set 10-20 feet from potato field edges. Several other non-pest psyllid species are routinely caught on yellow sticky traps in the PNW, so knowing how to recognize potato psyllid is important. For detailed information on monitoring psyllids using yellow sticky traps, see: <http://nwpotatoresearch.com/pdfs/PsyllidTrapping.pdf>.

**Management—biological control**

Since nymphs are essentially sedentary, they likely are fed upon by a wide range of predators like *Orius* pirate bugs, *Geocoris* big-eyed bugs, and *Nabis* damsel bugs.

**Management—chemical control: HOME USE**

- cyfluthrin
- esfenvalerate
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Note:** Pyrethroid (Group 3 in Tables 1-2) applications make aphid management more difficult and can lead to outbreaks of aphids, thrips, and spider mites.

**Management—chemical control: COMMERCIAL USE**

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Slug

Grey field slug or grey garden slug (*Deroceras reticulatum*)

**Pest description and crop damage** This slug is native to northern Europe, North Africa, and the Atlantic Islands. It is present in the U.S. in several states and was first reported damaging potatoes in storage in 2017.

**Biology and life history** Little is known about the biology of the species related to potatoes in the field and in storage. They damage harvested potatoes by building thick galleries that are different than the ones described for wireworms or tuberworms. In general, the entry hole is round and slugs of different sizes can be found inside tubers. Galleries can be subsequently infested by flies or saprophytic beetles.

**Scouting and threshold** Slugs are not a common problem in potato production, thus, there are no established scouting methods and thresholds.

**Management** If there is a slug problem in a storage unit it is because slugs are coming from the field, thus, potatoes entering storage should be slug-free. The only report in the literature on infestation in storage is from the Netherlands where the pest was controlled with a sprout inhibitor. For more information see <https://link.springer.com/article/10.1007/s12230-019-09728-5>.

### Management—chemical control: HOME USE

- iron (ferric) phosphate bait—Slower activity than metaldehyde baits, and application rate is three to four times higher than that of metaldehyde. Some formulations are OMRI-listed for organic use.
- metaldehyde bait—Broadcast to seedbed around borders and between rows. Do not apply directly to plants. Use this product with caution, as it is toxic to pets.
- sodium ferric EDTA

## Potato, Irish—Spider mite

Twospotted spider mite (*Tetranychus urticae*)

**Pest description and crop damage** Spider mites are tiny, spider-like animals that produce webs and are generally found on the undersides of leaves. Mite damage in potatoes is a minute stippling of the leaves and sometimes a bronzing. Mites reproduce rapidly and can build up to unmanageable populations in just a few days under the right conditions. What causes this population explosion, and allows the mites to take down fields, is uncertain, but some contributing factors include:

- Application of nonselective pesticides, such as pyrethroids, and certain carbamates and organophosphates, which negatively impact mite predators and allow spider mites to increase.
- Proximity to certain crops such as corn, alfalfa, and mint, which tend to harbor mites.
- Proximity to dusty roads.
- Hot, dry weather.

The first is the most important factor. In most cases, mite outbreaks in potatoes are an induced problem, brought on by management practices aimed at other pests.

**Biology and life history** Spider mites overwinter in leaf litter and other debris on the soil surface. Two-spotted spider mite has a very wide host range and in spring colonizes many weeds, crops, and native plants. It thrives in hot weather and can build up large populations rapidly during summer.

**Scouting and thresholds** Mite management requires early scouting and requires a hand lens. Initial mite infestations can be spotty within fields, making it important to sample for mites in several locations in each field. Because mites reproduce better on stressed plants, it is a good idea to check areas of fields that tend to be stressed for some reason (e.g., dry spots, low spots, and edges). Look for webbing and yellow stippling at leaf margins. It is also wise to check the edges of fields nearest to crops likely to harbor mites. Try to recognize mite populations before significant damage is noted and certainly before webbing is noticeable. There is no established treatment threshold for spider mites in potatoes, but it is well-known that treatments must be applied early in the infestation process to achieve control.

### Management—biological control

Spider mites are known to be strongly affected by predatory mites in some cropping systems, especially perennials such as tree fruits. Many species of insects are also known to feed on spider mites, including predatory bugs, thrips, lacewings, and ladybird beetles.

### Management—chemical control: HOME USE

Miticides must be applied at low thresholds to achieve effective control. Once populations exceed five mites per leaf, control may be difficult.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- plant essential oils (e.g., cottonseed, clove, garlic, rosemary) have shown some efficacy against spider mites—Some formulations are OMRI-listed for organic use.
- sulfur (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.

### Management—chemical control: COMMERCIAL USE

Miticides must be applied at low thresholds to achieve effective control. Once populations exceed five mites per leaf, control with miticides may be difficult.

See:

Pesticide Tables for Potato Pests

## Potato, Irish—Stink bug

Pentatomidae - several species

**Pest description and crop damage** Stink bugs that damage potatoes are usually large (0.37 inch), green, shield-shaped bugs. In the Columbia Basin, *Chlorochroa* is a common genus affecting potatoes. They feed by sucking plant sap. Stink bug damage is usually a flagging of leaflet, leaf, or stem. For example, damage caused by feeding at the base of a leaf can cause the entire leaf to wilt. Stink bugs are pests of potatoes in isolated pockets in the PNW. It is important to note that there are two species of large stink bugs in potatoes that are predators of Colorado potato beetle and caterpillars. Photos of these beneficial stink bugs can be seen at: <http://www.nwpotatoresearch.com/IPM-StinkBugs2.cfm>.

**Biology and life history** Stink bugs colonize potatoes from other crops and from native plant communities. Eggs are laid in masses of a few dozen at a time. Nymphs (5 instars) can develop quickly and form large populations under the right conditions.

**Scouting and thresholds** Stink bug adults often congregate in potato fields, gathering in large groups on small patches of plants. Therefore, detecting an infestation can be challenging, but on the other hand finding a congregation of bugs in one small area may lead to incorrect assumptions about the level of infestation throughout the field. Stink bug adults and nymphs are both easily detected during normal scouting operations using a beating sheet/tray.

### Management—biological control

Like most pests of potatoes, stink bugs are preyed upon primarily by the many generalist predators living in most potato fields.

### Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

See:

Pesticide Tables for Potato Pests

## Potato, Irish—Thrips

Onion thrips (*Thrips tabaci*)

Western flower thrips (*Frankliniella occidentalis*)

**Pest description and crop damage** Thrips are minute, slender bodied insects (0.5 to 1.0 mm in length). Wings may be present or absent and are unlike normal insect wings; thrips wings are essentially thin rods lined with long hairs. Thrips feed on potato leaves by rasping plant cells and sucking out their contents. Thrips feed on leaves and flowers, but in potatoes are most commonly found on the underside of leaves. Use of a hand lens or magnifying glass will aid in their detection and identification. Populations of thrips are low in the early spring and build up over time and can become very dense. Damage on potato leaves looks somewhat like mite damage, i.e., there are often small patches of damaged leaf tissue that are paler than surrounding healthy tissue.

**Biology and life history** Both western flower thrips and onion thrips have wide host ranges, including most crop plants, weeds, and many native plants in the PNW. In potato, over 90% of thrips found are western flower thrips. Adults overwinter in plant debris and other protected sites, emerging in spring to lay eggs in plant tissue. Thrips have a complex life cycle in which the last two immature stages are hidden and non-feeding. During the growing season, there are many overlapping generations, with a substantial portion of the population at any given time in one of the non-feeding stages, largely protected from pesticides and other management tactics. This, and the fact that thrips eggs are laid inside plant tissue, makes thrips very difficult to control since they rebound quickly as new adults and nymphs emerge daily from these hidden places.

**Scouting and thresholds** Monitoring for thrips is important because catching a population build up early is necessary to achieving effective control. There are no established thresholds or scouting techniques for thrips in potatoes. Beating sheet/tray techniques detect thrips, but it is unclear how accurately this sampling can estimate population size.

## Management—biological control

Thrips are food to many generalist predators, especially *Orius* spp., and just as in the case of aphids, preservation of predatory insects and spiders via careful use of insecticides can reduce the risk of damaging thrips populations.

## Management—chemical control: HOME USE

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- carbaryl
- cyfluthrin
- deltamethrin
- horticultural oil—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- malathion
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- plant essential oils (e.g., canola, clove, garlic)—Have shown some efficacy in controlling thrips. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

## Management—chemical control: COMMERCIAL USE

It is unclear how significant thrips damage can be on potatoes, however, growers commonly treat for the pest in the Columbia Basin of Washington. Very few products, however, list thrips under the pests controlled.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Tuberworm

Potato tuberworm, potato tuber moth (*Phthorimaea operculella*)

**Pest description and crop damage** During the growing season, tuberworm caterpillars feed as leaf miners inside leaves. They later may live inside stems or within groups of leaves tied together with silk. Tubers are also a food source for the caterpillars, especially exposed tubers and those within 2 inches of the soil surface. Larvae can infest tubers by leaving the foliage and finding available tubers to invade, or adults may find exposed tubers for egg laying. Regardless of the method, tuber damage is the main concern with tuberworms.

Tuber damage is often near the surface, consisting of broad, flat tunnels or furrows in the skin. Caterpillars may also burrow deep into tubers. Tunnels left by tuberworms look dirty, and their openings may be marked by collected droppings of the caterpillar.

**Biology and life history** Tuberworm in the PNW overwinters as a fully fed caterpillar or pupa, either in potato storage buildings or associated with tubers left in the field after harvest. Observations in Washington and Oregon have confirmed population buildup in fields after harvest, with moths living in the tubers remaining in the field. Adult moths are present throughout the winter in the Columbia Basin of Oregon and Washington. Tuberworm undergoes at least 3 generations per year in central Washington and Oregon. Populations are small early in the season due to the bottleneck of overwintering. The heat of summer encourages populations to grow, with the most tuberworm activity occurring in September and October. Moths disperse during the growing season and can spread far from their presumed overwintering locations by the end of the growing season. For more information, see <https://extension.oregonstate.edu/catalog/pub/pnw-594-biology-management-potato-tuberworm-pacific-northwest>.

**Scouting and thresholds** The simplest way to monitor tuberworm is to use pheromone-baited traps to catch adult male moths. The recommended established treatment thresholds in the PNW is 8-10 moths per trap per day. We know that pheromone traps are very effective at detecting the presence of tuberworm in an area. For the large fields common in the Columbia Basin, it is best to have more than one trap per field to be sure infestations are detected. Traps must be placed in the direction of prevailing winds. For detailed information on monitoring tuberworm using pheromone traps, see: [nwpotatoresearch.com/pdfs/PotatoProgressVIII\(10\).pdf](http://nwpotatoresearch.com/pdfs/PotatoProgressVIII(10).pdf).

## Management—biological control

Parasitoid wasps have been observed to kill some tuberworm larvae, but prevalence appears to be low. Research shows that a tuberworm-specific virus has potential for controlling tuberworm via application with commercial equipment, but no virus product is currently available on the market in the U.S.

## Management—cultural control

Tuber damage is the most important aspect of tuberworm management, and there are some simple means to help protect tubers from infestation. Prompt harvesting after vine kill can be very effective. Harvesting under green vines may be best, since tuberworm prefers living in the foliage. Keeping soil wet, especially as vines die, may be very important. Anything that keeps tubers more than 2 inches deep will be protective; deep tuber set, hilling practices, or covering hills after vine kill can prevent tuber damage. Potatoes should not be grown under furrow irrigation in areas where tuberworm is prevalent.

### Management—chemical control: HOME USE

- cyfluthrin
- esfenvalerate
- permethrin
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

Most products labeled for tuberworm control seem to reduce larval populations very effectively in foliage. How this translates to tuber protection is still uncertain. Tuberworm management, in the long term, will almost certainly have to include various cultural methods, in combination with insecticides. All fields potentially exposed to tuberworm should be monitored using pheromone traps. Some products, other than those listed below, may soon have tuberworm control claims on their labels.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Whitefly

**Includes** greenhouse whitefly (*Trialeurodes vaporariorum*)

**Pest description and crop damage** Adults resemble tiny white moths about 0.1 inch long. Immature forms look like scale insects and are completely sedentary after the first nymphal instar. Whiteflies occur in most potato fields by season's end but rarely become very dense. They rarely, if ever, require control in PNW potatoes. In potatoes grown in greenhouse for seed, white flies can be a nuisance.

**Biology and life history** Greenhouse whitefly is a common pest of many crops and ornamental plants all over the world. Eggs are laid individually on leaves, the immature stages remaining on the same leaf throughout development. Therefore, larger whitefly nymphs will be found on mid-canopy leaves. The final immature stage is much like a pupa, with the adult developing inside the cast nymphal skin. Whiteflies have short generation times, with multiple generations per season.

**Scouting and thresholds** As noted above, whiteflies rarely reach populations requiring control, reducing the importance of including them in scouting programs. Adult whiteflies are easy to spot flying within the plant canopy. Whitefly nymphs are much more difficult to measure – a leaf sampling scheme is required since they are not dislodged during beating sheet/tray sampling. There is no established treatment threshold for whiteflies in PNW potatoes since they are not common in the region.

### Management—biological control

Whiteflies are prey for many generalist predators as well as specific parasitoids. This may partially explain the infrequency with which they become abundant in PNW potatoes. In greenhouses, *Encarsia formosa*, commercially available, is an excellent biological control agent.

### Management—chemical control: HOME USE

For best results, direct spray toward undersides of leaves. Read label application instructions carefully.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- capsaicin—Some formulations are OMRI-listed for organic use.
- cyfluthrin
- deltamethrin
- esfenvalerate
- horticultural oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage it acts to repel certain insect pests. Some formulations are OMRI-listed for organic use.
- permethrin
- plant essential oils (e.g., clove, garlic, rosemary)—Have shown some efficacy against whitefly. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

### Management—chemical control: COMMERCIAL USE

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—White grub

Scarabaeidae

**Pest description and crop damage** The term white grub is used for the larvae of any number of species of beetles in the family Scarabaeidae. Some of these are small beetles with larvae less than 0.5 inch long, while other species can be large with larvae well over 1 inch. White grubs have a pale

body and brown head; they are often found curled into a 'C' shape. These beetles live in the soil and feed on roots and sometimes potato tubers, causing shallow, wide depressions in tubers. They rarely cause significant damage in potatoes in the PNW, most often being found in the spring as soil is prepared for potatoes and other crops or in soils with high organic matter.

**Biology and life history** Little is known about the biology of white grubs that infest PNW potato fields. Eggs are deposited in the ground and hatch as larvae that remain under the ground. They are rarely a problem in the PNW.

**Management—chemical control: HOME USE**

- azadirachtin (neem oil)—Some formulations are OMRI-listed.
- carbaryl
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad (as a mix with insecticidal soap)—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

A few bifenthrin products applied in-furrow are labeled for control of white grubs.

*See:*

Pesticide Tables for Potato Pests

## Potato, Irish—Wireworm

**Includes** *Limoniusspp.* and *Agriotes spp.*

**Pest description and crop damage** Wireworms are the most important soil-dwelling pests infesting crops in the PNW. The adults, known as click beetles (Elateridae family) feed on flowers but do little or no damage to the crop. The larval or immature stages cause major damage to seedlings and the underground portions of many annual crops. The larvae are shiny white at first, but later become straw color or light brown. They look wiry and are about 1 inch long when mature.

Several kinds of wireworms are in the PNW. Those causing the most damage in irrigated land are the Pacific Coast wireworm (*Limoniusspp.*), the sugar beet wireworm (*L. californicus*), the western field wireworm (*L. infuscatus*), and the Columbia Basin wireworm (*L. subauratus*). Of these, Pacific Coast and sugar beet wireworms are the most common species. Land with annual rainfall less than 15 inches may be infested with the Great Basin wireworm (*Ctenicera pruina*). As a result, there may be serious damage when irrigated crops are grown on sagebrush or dry wheat land. This species tends to disappear after a few years of intensive irrigation, but may be replaced by the more serious *Limoniusspp.*, which favor moist conditions. West of the Cascade Mountains, other species of wireworms, including *Agriotes spp.*, are pests.

No crop is immune to attack by wireworms, but these pests are most destructive on beans, corn, grain, watermelons, and other annual crops. In potatoes, serious damage results from wireworms tunneling in tubers during feeding. Wireworms damage seed potato after planting and developing tubers later. Wireworm damage most often is characterized by holes bored directly into the tubers. These holes frequently are healed over, indicating that damage occurred sometime before harvest. Processors have a very low tolerance for wireworm damage and zero tolerance for wireworms in raw product. Damage is commonly confused with tuberworm damage.

**Biology and life history** Depending on species, wireworms may require two to six years to mature. They overwinter 12 to 24 inches deep in the soil and return near the surface in spring to resume feeding. Mature larvae pupate in the soil, developing into adults that will remain in the soil until the following spring, when they emerge, mate, and lay eggs. Because the female beetles fly very little, infestations do not spread rapidly from field to field.

Soil temperature is important to wireworm development and control. Larvae start to move upward in the spring, when soil temperature at the 6 inch depth reaches 50°F. Later in the season, when temperatures reach 80°F and above, the larvae tend to move deeper than 6 inches, where most remain until the following spring. For more information, see <https://catalog.extension.oregonstate.edu/pnw607> and <https://catalog.extension.oregonstate.edu/em9166>.

**Scouting and thresholds** Ideally, the presence of wireworm in a field should be determined before using control measures. However, effectively determining wireworm density is difficult and/or impractical on the large fields that are the rule in many areas. Crop sequence also is important; thus, planting a susceptible crop such as potatoes immediately after red clover or grain is risky.

In fields that are plowed deeply in the fall, wireworms will turn up during plowing. They may be detected by following behind the plow and checking for them in the turned-up soil. Fall plowing, however, is becoming much less common.

There are no established treatment thresholds for wireworms in potatoes. Management decisions are a complex assessment of crop history, scouting, previous pesticide treatments, etc.

**Management—cultural and biological controls**

Crop rotation is an important tool for wireworm control. Wireworms tend to increase rapidly among red and sweet clover and small grains (particularly barley and wheat). Birds feeding in recently plowed fields destroy many wireworms. However, in seriously infested fields this does not reduce the overall pest population below economic levels. To date, field tests of entomopathogenic nematodes in wireworm infested fields show they do not effectively control wireworms. There are no parasites or biological insecticides known to be effective in wireworm control, but research is ongoing in this area. An important management consideration is avoiding prolonged periods of time between vine death and harvest. Typical wireworm damage occurs mid-season and results at harvest in healed holes in tubers; however, tubers left in the field for weeks after vine death can

be re-infested resulting in serious tuber damage and tubers containing wireworms at harvest.

For more information, see <http://cdn.intechopen.com/pdfs/28267.pdf>

**Management—chemical control: HOME USE**

- azadirachtin (as a mix with pyrethrins)—Some formulations are OMRI-listed for organic use.
- bifenthrin (as a mix with zeta-cypermethrin).
- cyfluthrin
- zeta-cypermethrin

**Management—chemical control: COMMERCIAL USE**

*See:*

Pesticide Tables for Potato Pests

**Table 1. Single active ingredient products**

Type	Active Ingredient	Trade Name	Target Pest(s)	Insecticide Group	Signal Word	Restricted Use?	REI	PHI (days)
FU	1,3 dichloropropene	Telone II (Dow)	symphytan, wireworm	Soil fumigant	Warning	Y WA Only	5 days	NA
F	abamectin (a.k.a. avermectin B1)	Agri-mek, Epi-Mek (Syngenta), Abacus (Rotam), Reaper (Loveland), Abba Ultra (Makhteshim Agan),	Colorado potato beetle, potato psyllid, spider mite, thrips	6	Warning	Y	12 hr	14
F	acetamiprid	Assail 30SG, Assail 70WP, Intruder Max 70WP (United Phosphorus)	aphid, beetle, leafhopper*, potato psyllid*	4A	Caution	N	12 hr	7
F	afidopyropen	Sefina (BASF)	aphid, whitefly, potato psyllid*	9D	Caution	N	12 hr	7
F	bifenazate	Acramite (UPLCrompton)	spider mite	25	Caution	N	12 hr	14
IF, F	bifenthrin	Capture LFR, Brigade 2EC (FMC), Fanfare 2EC (Makhteshim Agan), Tundra EC (Winfield) BiFenture EC (United Phosphorus)	beetle, various soil grubs, wireworm. Lepidoptera*, spider mite*, leafhopper*, lygus*, potato psyllid*	3	Warning	Y	12 hr	21
IF	carbaryl	Sevin 4F, Sevin 80S, Sevin XLR Plus (Bayer), Sevin 5 Bait (Wilbur Ellis)	beetle, Lepidoptera, stink bug, leafhopper, potato psyllid*; various soil-inhabiting arthropods (5 Bait)	1A	Caution or Warning depending on formulation	N	12 hr	7
F	chlorantraniliprole	Coragen (FMC) Vantacor (FMC)	Colorado potato beetle, Lepidoptera	28	None	N	4 hr	14

**Table 1. Single active ingredient products**

Type	Active Ingredient	Trade Name	Target Pest(s)	Insecticide Group	Signal Word	Restricted Use?	REI	PHI (days)
F, IF	clothianidin	Belay 50WDG, Belay (Valent)	beetle, aphid, leafhopper, psyllid	4A	Caution	N	12 hr	14
IF	cyantraniliprole	Verimark (FMC), Exirel (FMC)	Colorado potato beetle, Lepidoptera	28	Caution	N	4 hr	-2
F	cyfluthrin	Tombstone (Loveland)	beetle, Lepidoptera, leafhopper, potato psyllid,	3	Warning	Y	12 hr	0
F	beta-cyfluthrin	Baythroid XL (Bayer)	beetle, Lepidoptera, leafhopper, potato psyllid	3	Warning	Y	12 hr	0
F	lambda-cyhalothrin	Warrior, Warrior II (Syngenta), Province (Tenkoz), Silencer (Makhteshim Agan), Lambda-Cy (United Phosphorus)	aphid, beetle, grasshopper, leafhopper, Lepidoptera, potato psyllid, stink bug	3	Warning	Y	24 hr	7
	alpha-cypermethrin	Fastac CS, Fast EC (BASF)	aphid, beetle, grasshopper, leafhopper, Lepidoptera, lygus		Caution	Y	12 hr	1

F	zeta-cypermethrin	Mustang, Mustang Max (FMC)	aphid, beetle, grasshopper leafhopper, Lepidoptera, lygus	3	Warning	Y	12 hr	1
F	cyromazine	Trigard (Syngenta)	Colorado potato beetle	17	Caution	N	12 hr	7
F	deltamethrin	Delta Gold1.5ec (Winfield Solutions)	beetle, leafhopper, Lepidoptera,	3	Danger/ Poison	N	12 hr	3
F	dimethoate	Many brands and formulations	aphid, grasshopper, leafhopper, potato psyllid*	1B	Warning	N	48 hr	0
F, IF	dinotefuran	Scorpion 35 SL (Gowan), Venom (Valent)	beetle, leafhopper, potato psyllid	4A	Caution	N	12 hr	7
F	esfenvalerate	Asana (Valent), S-FenvaloStar (LG Lifesciences), Zyrate (Rotam)	beetle, grasshopper, leafhopper, Lepidoptera, potato psyllid	3	Warning	N	12 hr	7
F	fenpyroximate	Miteus (Nichino), Portal (Nichino),	leafhopper, potato psyllid, spider mite	21A	Warning	N	12 hr	7
IF	fipronil	Regent 4SC (BASF)	wireworm	2B	Warning	Y	0 hr	90
F	flonicamid	Beleaf 50 SG (FMC) Carbine 50 WG (FMC)	aphid, potato psyllid, thrips*, whitefly	29	Warning or Caution	N	12 hr	7
F	flupyradifurone	Sivanto HL (Bayer), Sivanto 200 SL (Bayer), Sivanto Prime (Bayer)	aphid, leafhopper, potato psyllid, Colorado potato beetle, whitefly	4D	Caution	N	4 hr	7
F	hexythiazox	Many brands and formulations	potato psyllid, spider mite,	10A	Caution	N	12 hr	21
IF, F, SP	imidacloprid	Many brands and formulations	aphid, beetle, leafhopper, potato psyllid, wireworm (seed piece damage)	4A	Caution	N	12 hr	14
F	indoxacarb	Avaunt (FMC), Asvaunt eVo (FMC), Avaunt Insecticide (FMC), Comber (Sharda)	Lepidoptera, Colorado potato beetle	22	Caution	N	12 hr	7
F	malathion	Many brands and formulations	aphid, blister beetle, grasshopper, leafhopper	1B	Warning or Caution	N	12 hr	0
F	methomyl	Lannate LV, Lannate SP (Corteva), Nudrin LV, Nudrin SP (Albaugh), Lanveer LV (Innvictis)	aphid, flea beetle, leafhopper, Lepidoptera, Colorado potato beetle*, lygus*, potato psyllid*	1A	Danger/ Poison	Y	48 hr	6

**Table 2. Package mixes of active ingredients.**

Type	Active Ingredient 1	Active Ingredient 2	Trade Name	Target Pest(s)	Signal Word	Restricted use?	REI	PHI (days)
FU	1,3 dichloropropene	chloropicrin	Telone C17 (Dow)	symphylan, wireworm	Danger	Y	5 days	NA
F	abamectin (a.k.a. avermectin B1)	bifenthrin	Athena (FMC)	aphid, beetle, grasshopper, Lepidoptera, lygus, potato psyllid, spider mite, thrips	Caution	Y	12 hr	21
F	abamectin	zeta-cypermethrin	Gladiator (FMC)	aphid, beetle, leafhopper, Lepidoptera, lygus, potato psyllid, spider mite, thrips	Caution	Y	12 hr	14
	abamectin	cyantraniliprole	Minecto Pro (Syngenta)					
F	abamectin	thiamethoxam	Agri-Flex (Syngenta)	beetle, leafhopper, potato psyllid, spider mite	Warning	Y	12 hr	14

**Table 2. Package mixes of active ingredients.**

Type	Active Ingredient 1	Active Ingredient 2	Trade Name	Target Pest(s)	Signal Word	Restricted use?	REI	PHI (days)
F	bifenthrin	imidacloprid	Brigadier (FMC), Skyraider (Adama), Swagger (Loveland)	aphid, beetle, leafhopper, Lepidoptera, grasshopper, potato psyllid, whitefly	Warning or Danger	Y	12 hr	21
F	bifenthrin	zeta-cypermethrin	Hero, Hero EW (FMC), Steed (FMC)	aphid, beetle, grasshopper, leafhopper, Lepidoptera, spider mite	Caution or Warning	Y	12 hr	21
F	chlorantraniliprole	lambda-cyhalothrin	Besiege (Syngenta)	aphid, beetle, grasshopper, leafhopper, Lepidoptera, stink bug, potato psyllid	Warning	Y	24 hr	14
F	chlorantraniliprole	thiamethoxam	Voliam Flexi (Syngenta)	aphid, beetle, leafhopper, Lepidoptera	Caution	N	12 hr	14
F	beta-cyfluthrin	imidacloprid	Leverage 360 (Bayer)	aphid, beetle, Lepidoptera, psyllid, leafhopper, lygus	Caution	Y	12 hr	7

**Table 2. Package mixes of active ingredients.**

Type	Active Ingredient 1	Active Ingredient 2	Trade Name	Target Pest(s)	Signal Word	Restricted use?	REI	PHI (days)
F	lambda-cyhalothrin	thiamethoxam	Endigo ZC, Endigo ZCX (Syngenta)	aphid, beetle, Lepidoptera, grasshopper, lygus, stink bug, potato psyllid, leafhopper, whitefly	Warning	Y	24 hr	14
SP	thiamethoxam	fludioxonil, (fungicide)	Cruiser Maxx (Syngenta)	aphid, beetle, leafhopper, potato psyllid, whitefly	Caution	N	12 hr	??
SP	thiamethoxam	fludioxonil, difenoconazole (fungicide)	Cruiser Maxx Potato Extreme (Syngenta)	aphid, beetle, leafhopper, potato psyllid, whitefly	Caution	N	12 hr	??
SP	thiamethoxam	fludioxonil, difenoconazole, (fungicide) Sedaxane (fungicide)	CruiserMaxx Vibrance	aphid, beetle, leafhopper, potato psyllid,	Caution	N	12 hr	??

**Table 3. Biological insecticides, essential oils, etc.**

Type	Active Ingredient	Trade Name	Target Pest(s)	Insecticide Group	Signal Word	Restricted Use?	REI	PHI (days)
F	azadirachtin	Many brands, and formulations	various insects	-	Caution	N	4 hr	0
	azadiractin, neem	Debug Optimo, Debug Tres, Debug Turbo (Agro Logistic Systems)	various insects	-	Caution	N	4 hr	0
F	azadiractin, pyrethrins	Azera (Valent)	various insects	3A	Warning	N	12 hr	0
F	<i>Bacillus thuringiensis</i> var. <i>aizawai</i>	Agree (Certis), XenTari (Valent), Jackpot WP (Certis)	Lepidoptera	11A	Caution	N	4 hr	0
F	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Many brands and formulations	Lepidoptera	11A	Caution	N	4 hr	0
F	<i>Bacillus thuringiensis</i> var. <i>tenebrionis</i>	Trident (Certis)	Colorado potato beetle	11A	Caution	N	4 hr	0
	<i>Beauveria bassiana</i> , strain ANT	BioCeres EC, BoiCeres WP (Anatis Bioprotection)	aphid, whitefly, thrips, lygus	-	Caution	N	4 hr	0
F	<i>Beauveria bassiana</i> , strain GHA	Many brands, and formulations	various insects	--	Caution	N	4 hr	0
F	<i>Beauveria bassiana</i> , strain PPRI	Velifer Bioinsecticide/Miticide, Velifer Fungal Contact Insecticide /Miticide (BASF)	aphid, thrips, whitefly, spider mite	_	Caution	N	12 hr	0
F	<i>Burkholderia</i> spp.	Many brands, and Formulations	Lepidoptera, aphid, leafhopper, potato psyllid, whitefly, Spider mite	-	Caution	N	4 hr	0
F	extract of <i>Chenopodium ambrosioides</i>	Requiem (Bayer)	potato psyllid	--	Caution	N	4 hr	0
F	<i>Chromobacterium subsugae</i> strain PRAA4-1T	Grandevo CG, Grandevo WDG (ProFarm)	Lepidoptera, aphid, leafhopper, potato psyllid, whitefly	--	Caution	N	4 hr	0
F	kaolin	Surround CF, Surround WP (Novasource), Cocoon (Sipcam Agro)	beetle, grasshopper, leafhopper, lygus, spider mite	--	Caution	N	4 hr	0

**Table 3. Biological insecticides, essential oils, etc.**

Type	Active Ingredient	Trade Name	Target Pest(s)	Insecticide Group	Signal Word	Restricted Use?	REI	PHI (days)
F	neem oil	Trilogy (Certis)	aphid, whitefly, thrips, spider mite	-	Caution	N	4 hr	0
F	petroleum-derived oil	Many brands	leafhopper, mite, whitefly, aphid transmission of Potato Leafroll Virus and PVY	--	Caution	N	4 hr	0
F	potassium salts of fatty acids	M-Pede (Gowan),DES-X (Certis)	leafhopper, lygus, thrips, mites, whitefly	--	Warning	N	12 hr	0
F	vegetable oils and combinations, including rosemary, peppermint, clove, thyme, garlic, sesame, soybean geraniol	Many brands and formulations	various insects	-	Caution or Warning	N	0-4 hr	0
F	spinosad	Many brands and formulations	Lepidoptera,, Colorado potato beetle, thrips, potato psyllid	5	Caution	N	4 hr	7
IF	spinosad, iron phosphate	BUG-N-SLUGGO (Certis)	Lepidoptera, slug	5	Caution	N	4 hr	7

All trade names may not be listed here. In some cases the PHI is not specifically mentioned, but is implied to be 0 days, thus, the REI becomes the PHI. Product application codes: F = foliar; IF = in-furrow. Insecticide group codes refer to modes of action, and should be used in managing insecticide resistance; for more on insecticide codes and resistance management, see: <http://www.nwpotatoresearch.com/>. Always consult specific pesticide labels before making recommendations or deciding on a product and treatment.

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# Mushroom Pests

Allison Willette and Craig Hollingsworth

Latest review—March 2024

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In all cases, follow the instructions on the pesticide label. The *PNW Insect Management Handbook* has no legal status, whereas the pesticide label is a legal document. Read the product label before making *any* pesticide applications.

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## Mushroom—Mushroom fly

Cecid flies (*Mycophila speyeri*, *Heteropeza pygmaea*)

House fly (*Musca domestica*)

Phorid fly (*Megaselia halterata*)

Sciarid fly (*Lycoriella mali*)

Stable fly (*Stomoxys calcitrans*)

**Pest Biology and Crop Damage** The morphology of most mushroom flies have four distinct life stages: eggs, larvae, pupae and adult. The major insect pest of mushrooms is the sciarid fly, a small black insect about 0.25 inch long, with long antennae and gray wings folded over the back. Sciarid larvae attack compost, spawn, mycelia, pins, and mushroom stems and caps. Phorid flies are very small, 0.125 inch long (half the size of a fruit fly), with a humpback appearance and very small antennae. They are stockier than sciarids and are very active, running and hopping erratically. These flies feed on mycelia, depressing crop yields. Both sciarid and phorid adults carry disease organisms into the crop. Cecid species are rarely seen as adult flies, because under the warmth of mushroom culture larvae become “mother larvae” giving birth directly to 10–30 daughter larvae. Cecids feed on the mushroom stems or gills, reducing marketable yield. Stable fly and house fly are common pests in compost wharves.

### Management—cultural control

Cultural control, including sanitation, composting and pasteurization is the basis for successful mushroom culture. Cultural practices that can reduce pest fly populations include exclusion, sanitation (washing and sanitizing), shortening crop cycles and post-harvest steam cleaning. In compost wharves, fly populations can be reduced by promoting drainage and reducing of standing. Fly exclusion is critical: rooms should be sealed and properly screened to exclude breeding flies. Attention should be paid to doors, fans, ceiling joints, drains and ductwork. Lights and traps near doorways may be of value. Equipment and personnel should not move from older culture rooms (where infestations tend to exist) to newer, uninfested rooms. Limit the amount of time that doors are left open.

### Management—biological control

A number of entomopathogenic nematodes are used successfully against mushroom flies because of the moist organic growing media. *Steinernema feltiae* is effective against sciarids. *Howardula hussey* occurs naturally in phorid populations. *Bacillus thuringiensis israelensis (Bti)* is a bacterium used widely in biocontrol of flies: *Bti* appears to be more effective against earlier instar sciarid larvae.

In compost wharves, augmentation of naturally occurring pteromalid wasps is used for control of house fly and stable fly: *Spalangia endius*, *Muscidifurax raptor*, *M. zaraptor*, and *M. raptorellus* are commercially available.

### Management—chemical control

**Note:** Some labels specify *Agaricus bisporus* (the button mushroom) as the intended crop. In such cases, the product is registered legally for use *only* on *Agaricus* mushrooms.

## Mushroom sites, pests, and controls

Site	Controls —follow label rates—	Comments and cautions
Empty mushroom house and premises	azadirachtin DDVP (empty house only) MGK 264 (empty house only) pyrethrin + PBO permethrin (empty house only)	
Filling	azadirachtin Geranium oil; peppermint; rosemary	
Spawning	azadirachtin <i>Bacillus thuringiensis sp. israelensis</i> <i>Beauveria bassiana</i> GHA cyromazine <sup>1</sup> Geranium oil; peppermint; rosemary <i>Isaria fumosorosea</i>	To be effective, pesticides must be incorporated thoroughly into the compost. It is important that end sections and sides be treated completely.
Casing	azadirachtin <i>Bacillus thuringiensis ssp. israelensis</i> <i>Beauveria bassiana</i> GHA Geranium oil; peppermint; rosemary <i>Isaria fumosorosea</i> <i>S-methoprene</i>	Drench onto casing layer with sufficient water for good penetration.
Growth—Pinning	Azadirachtin malathion pyrethrin + PBO permethrin	Adult fly control.
Picking	pyrethrin + PBO (aerosol)	Use effectively to knock down adult flies prior to pickers entering rooms.

<sup>1</sup>Cyromazine-treated spent compost cannot be used to grow food crops.

## Pesticides registered for use in mushroom houses and/or on mushroom crops

Common name	Brand names	Class1	Toxicity class	Uses and precautions
azadirachtin (neem)	Azatin, Align, Azasol, Debug Tres	BP	IV; very low	Sciarid and phorid fly control incorporated into compost or casing soil; disrupts fly development. Some formulations are OMRI-listed for organic use.
<i>Bacillus thuringiensis ssp. israelensis</i>	Gnatrol DG	MI	IV; very low	Sciarid and phorid fly control incorporated into compost or casing soil; disrupts fly development at the larval stage.

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<i>Beauveria bassiana</i> GHA	Botanigard	MI	IV; very low	Sciarid and phorid fly control incorporated into compost or casing soil; fungus infects fly larvae. Some formulations are OMRI-listed for organic use.
cyromazine	Armor, Aegis	IGR	III; low	Sciarid fly control incorporated into compost; disrupts fly development. Spent, treated compost cannot be used to grow food crops.
DDVP, dichlorovos	Nuvan Fog 5%	OP	I; high	Phorid flies. Empty houses, and no less than 10 days before mushrooms in beds
Geranium oil; peppermint; rosemary	Brandt Ecotec Plus	BP	IV; very low	Controls larval stage of flies.
<i>Isaria fumosorosea</i>	Ancora, PFR-97TM 20% WDG	MI	IV; very low	Sciarid and phorid flies, at spawning, casing and during case hold. Some formulations are OMRI-listed for organic use.
malathion	Malathion	OP	III; low	Sciarid and phorid flies, applied after picking.
MGK 264	Alto Cirrus, Cirrus Fogging	synergist	III; low	Fly control in empty mushroom houses. Use as diluted space spray or contact for accessible stages of flies.
permethrin	Ambush, Pounce	SP	II–III; medium-low	Sciarid and phorid fly control as a fog, aerosol, or dust treatment for adult flies. Do not use when mushrooms are present.
piperonyl butoxide (PBO)		synergist	IV; very low	Improves activity of other ingredients; usually combined with pyrethrins.
pyrethrin, pyrethrum	many	NP	III; low	Aerosol or liquid; general insect control; very rapid knockdown. Some formulations are OMRI-listed for organic use.
S-methoprene	Apex	IGR	III; low	Intended as larva and egg control. Use adult knockdown for high infestations.

1BP = biopesticide; IGR = insect growth regulator; MI = mycoinsecticide; NP = natural pyrethrum; OP = organophosphate; SP = synthetic pyrethroid.

Note: Some labels are labeled for use on *Agaricus* mushrooms only.