

Agronomic Crops

Farm-Stored Grain Pests

John Rinehold

Latest revision—March 2020

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.

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

Stored grain pests

Includes

Almond moth (*Ephestia cautella*)
Angoumois grain moth (*Sitotroga cerealella*)
Flour beetle (*Tribolium* spp.)
Granary weevil (*Sitophilus granaries*)
Indian meal moth (*Plodia interpunctella*)
Maize weevil (*Sitophilus zeamais*)
Rice weevil (*Sitophilus oryzae*)
Saw-toothed grain beetle (*Oryzaephilus surinamensis*)

Storing grain properly

Store only clean, dry grain containing less than 12 percent moisture. Grain mixed with green weed seeds, broken kernels, or dirt provides conditions favorable for insect development.

Aerate grain

Moisture condensation can develop in storage bins when unequal temperatures in the grain mass cause gradual circulation of air from the warm to the cold grain. As air passes through the warm center of the grain, small convection currents pick up moisture and deposit it in the cold areas. This can result in spoiled, crusted grain on the surface, in the middle of the bin, on top-center, or along the outside.

To prevent condensation, aeration is needed to keep the grain within 15°F of the average outside temperature. Start aeration fans shortly after harvest, and run them periodically until November. In the spring, aeration should be used to raise the temperature of the grain to about 50°F.

Inspect grain

Inspect stored grain once a month. You can detect infestations using a grain probe or by hand. Areas that are hot generally indicate an infestation. Watch especially for signs of crusting near the top-center and outside edges. You might see live insects and damaged kernels on the surface, especially at the crown. Surprisingly, large populations of these pests can develop by mid-winter. Light traps, pheromone kits, and other types of traps are available for collecting, detecting, and monitoring many pests.

Prevention

Good housekeeping and rapid inventory liquidation are key to preventing infestations. Before harvest and grain storage: (1) remove grain, or else treat grain that is to remain in storage. Grain stored over 9 months is susceptible to infestation; (2) thoroughly clean with industrial vacuum the storage warehouse, floors, walls, ceilings, cracks and crevices, and all equipment. The most common source of an insect infestation for newly stored grain is old grain residue which is everywhere: in and on trucks, trailers, combines, dump pits, bins, augers, and virtually anywhere that grain passes or is stored. Infestations may be introduced on pallets or in contaminated or infested bags of grain or seed, even though these may appear to be clean. Pelleted livestock feed, dry animal foods, feathers, and old hides may also harbor the pests that infest stored grain.

Protection

Insecticides are highly recommended for treating the interior walls and floor. Malathion products, Tempo Ultra SC and Tempo 20WP (cyfluthrin), and Storcide II (chlorpyrifos-methyl+deltamethrin) are registered for surface treatments. Apply according to label instructions. Bin wall and floor treatments should be made at least 1 week prior to filling. **Note:** No international level of tolerance has been established for cyfluthrin. Grain treated with this product may not be accepted in international markets. Avoid contaminating storage areas where exported grains may be stored. Caution—Some buyers will not accept insecticide-treated grain. Check with your local elevator before treating.

Grain to be stored 9 months or longer is often treated for protection against beetles and moths when augered into storage. The possibility exists for rapid infestation as the protectant breaks down; storage longer than 18 months is not recommended. Protectants are added to the grain as it is unloaded, or as it enters the bin for final storage. To be effective, protectants must be mixed thoroughly with the grain. If subsequent surface infestations are detected, try to determine the reason (e.g., a leaky roof leading to moistening of the grain) and correct the root cause. Minor infestations can be treated by incorporating a registered product into the top 8 to 10 inches of grain.

Management—chemical control

Direct grain treatments

- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP) at 0.5 lb in 5 to 10 gal of water per 500 sq ft of grain surface area, mix into top 4 inches for Indian meal moth, Angoumois grain moth, and almond moth. Mix with grain when placed in storage and/or periodically apply to surface of stored grain; see labels. Biobit HP is OMRI-listed for organic use.
- ◆ chlorpyrifos methyl/deltamethrin (Storcide II) at 5 gal of water final spray per 1,000 bu of grain. See manufacturer's recommendations for use with food-grade oil. Apply 3 ppm chlorpyrifos and 0.5 ppm deltamethrin to a moving grain stream headed for storage. Product rate per 1,000 bu is 12.4 fl oz for wheat, 9.9 fl oz for barley, and 6.6 fl oz for oats. Not labeled for corn.
- ◆ malathion dust admixture (Max Kill Dusta-Cide) at 0.6 lb ai per 1,000 bu, applied as grain is loaded or turned into final storage.
- ◆ malathion dust top dressing (Max Kill Dusta-Cide) at 0.3 lb ai/1,000 sq ft of grain surface. For Indian meal moth control. Limit 3 treatments of malathion product.
- ◆ methoprene (Diacon IGR) top dressing at 1 ml in water or food-grade oil per 1,000 sq ft of grain surface.
- ◆ methoprene (Diacon IGR) admixture at no more than 4.4 oz ai in 5 gal water or food-grade oil per 1,000 bu. Apply to the moving grain stream. Methoprene does not kill adult insects, but does prevent reproduction.
- ◆ methoprene/deltamethrin (Diacon IGR Plus) apply in 3 to 5 gal water or food based oil at label rates per 1,000 bu of grain.

- ◆ pirimiphos-methyl (Actellic 5E) admixture at 0.36 to 0.48 lb ai in 3 to 5 gal water or food-grade soybean oil to each 30 tons of commodity. Corn only.
- ◆ pirimiphos-methyl (Actellic 5E) top dressing at 0.12 lb ai in 2 gal water to each 1,000 sq ft of grain surface. Not labeled for wheat. Extreme heat results in volatilization and reduction in residual control. Corn only.
- ◆ pyrethrins/synergist (Pyrenone Crop Spray) as admixture in a 1.7% pyrethrin solution. Apply 4 to 5 gal per 1,000 bu of grain, applied as conveyed along belt or when entering the auger or elevator. Primarily for Indian meal moth control.
- ◆ pyrethrins/synergist (Pyrenone Crop Spray, TurboCide Gold) as top-dressing in a 3.3% pyrethrin solution. Apply 1 to 2 gal/1,000 sq ft of grain surface. Rake into grain to 4 inches.
- ◆ pyrethrins/synergist (Py-75) as a space spray per 1,000 cu ft. Rates vary; check label.
- ◆ silicon dioxide from diatomaceous earth (Perma-Guard) at 7 lb powder directly onto each ton of grain. Mix thoroughly. Perma-Guard is OMRI-listed for organic use.
- ◆ spinosad (Sensat) admixture at 1 ppm delivered to 1 ton of grain.
- ◆ spinosad (Sensat) top dressing mix 2.6 fl oz in 2 gal water per 1,000 sq ft of surface. Sensat label is not listed for organic use.

Storage building—residual spray or space treatment

- ◆ beta-cyfluthrin (Tempo SC Ultra) at 0.034 to 0.067 oz ai (8 to 16 ml)/1,000 sq ft as surface spray. No international level of tolerance has been established for cyfluthrin. Grain treated with this product may not be accepted in international markets. Avoid contaminating storage areas where exported grains may be stored.
- ◆ chlorpyrifos methyl/deltamethrin (Storicide II) at 0.4/0.07 oz ai (1.8 fl oz) in 1 gal water for treating empty grain bins. Apply 1 gal/1,000 sq ft. Bin and warehouse applications should only be applied from outside the structure. Use of automated spray equipment is mandatory when applying to empty bins. Not labeled for corn.
- ◆ cyfluthrin (Cy-Kick CS) at 0.05% to 0.1% spray formulated product. May be used to treat grain storage facilities. Do not apply to grain.
- ◆ cyfluthrin (Tempo 1% Dust). Apply as a crack and crevice treatment in grainaries. Do not apply to grain.
- ◆ ddvp (Max Kill Vapocide, Nuvan Aerosol)—Apply as a fog or ULV spray at 1 to 2 grams per 1,000 cu ft.
- ◆ deltamethrin (Suspend SC) at 0.08 to 0.5 lb ai per 100 gal final spray in grain bins and warehouses. Apply to surfaces at 1 gal per 1,000 sq ft.
- ◆ esfenvalerate/pyrethrins (MGK Shockwave) as contact spray or thermal fog in granaries, mills, elevators and other areas. Consult label. RTU for use in mechanical sprayers which generate aerosols.
- ◆ fenvalerate (Onslaught) at 0.025 to 0.05% (0.5 fl oz to 1 fl oz) per 1000 sq ft. Apply to cracks, crevices and other surfaces. Retreatment interval 14 days. Do not apply to grain.
- ◆ lambda-cyhalothrin (Demand CS) at 0.015 to 0.03% (0.2 to 0.4 fl oz/gal) as surface spray.
- ◆ malathion (Loveland Malathion 57EC) at 0.6 lb ai in 3 gal water and apply on 1,000 sq ft to grain storage facilities. Do not apply to grain.
- ◆ methoprene (Diacon IGR) may be used as a fogging concentrate. Methoprene does not kill adult insects, but rather prevents reproduction.
- ◆ pyrethrins/synergist (Py-75, Pyrocide 100, TurboCide Gold) as a contact spray per 1,000 sq ft and followed as a space spray per 1,000 cu ft. Rates vary; check label.
- ◆ tetradecadien acetate (Cidetrak IMM) as a space spray. Do not exceed 200 grams ai per 7063 cu ft per year.

Fumigants

Badly infested grain may require fumigation (release of a poisonous gas into the stored grain mass). Fumigation of large volume storage facilities is a specialized and potentially hazardous procedure. Contact local experts for guidance and materials.

Grain fumigants

- ◆ aluminum phosphide products—The tablet or pellet formulations are most suitable for farm applications; consult label for directions.
 - Solid aluminum phosphide formulations release hydrogen phosphide (phosphine) gas when exposed to moisture and heat. Warm, humid air accelerates the reaction while cool, dry air slows it down. The reaction starts slowly, gradually accelerates, and then tapers off.
 - Aluminum phosphide tablets and pellets may be applied to the grain mass by probing them below the grain surface, adding them as the grain is turned, or placing them in the aeration ducts below the grain mass. Treatment while turning the grain generally is not feasible in on-farm storage, and often alternative methods must be used to treat the grain in place.
 - In shallow bins, tablets may be probed into the grain using a 5- to 7-foot long hollow tube, designed for this purpose. These tubes can be purchased or made from electrical conduit or plastic pipe, according to distributor recommendations.
 - Sealing the bin is the single most important step in fumigation. Properly sealing grain bins before fumigation is essential for reaching and maintaining the required combination of gas concentration and exposure time necessary to kill grain pests.
 - Phosphine gas is also available in a pressurized container; consult label for directions.
- ◆ magnesium phosphide products—Similar to aluminum phosphide, though the more rapid release of phosphine may hinder penetration as well as endanger the applicator. Consult label for directions.
- ◆ methyl bromide is an effective grain fumigant for the control of stored grain insects at all stages of development. It converts into a gas at temperatures above 39°F and has virtually no odor or irritating qualities to indicate its presence. Consult label for directions.
- ◆ sulfuryl fluoride (ProFume) applied by trained staff for seeds of any commodities.

Field and Silage Corn Pests

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

Field and silage corn—Aphid

Includes

Bird-cherry oat aphid (*Rhopalosiphum padi*)

Corn leaf aphid (*Rhopalosiphum maidis*)

Pest description and crop damage Green and black aphids suck sap. They may become very abundant, especially later in the season. Large populations of aphids may reduce kernel number and size.

Management—chemical control

- ◆ abamectin/thiamethoxam (Avicta Duo Corn)—Apply as slurry to corn seed. Consult label.
- ◆ alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/a per season.
- ◆ azadirachtin (Aza-Direct) at 16 to 32 oz formulated product/a. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana* (Mycotrol ESO) at 8 to 32 fl oz/acre. REI 4 hr. PHI 0 day. OMRI-listed for organic use.
- ◆ bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.059 to 0.098 lb ai/a (suppression only). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.47 to 0.94 lb ai/a. PHI 21 days before harvest of grain or ears. Limit 3 applications. REI 24 hr. Apply as a postemergence broadcast spray or through overhead sprinklers. Do not exceed 3 lb ai/a per season for all chlorpyrifos treatments.
- ◆ *Chromobacterium subtsugae* (Grandevo) at 0.6 - 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ dimethoate (Dimethoate 400) at 0.33 to 0.5 lb ai/a. PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Do not apply during pollen shed if bees are foraging actively.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- ◆ flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a. PHI 7 days forage; 21 days grain, stover or straw. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per season.

- ◆ malathion (Fyfanon 8, Gowan Malathion 8) at 0.6 to 1 lb ai/a. PHI 7 days. REI 12 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- ◆ methomyl (Lannate SP) at 0.22 to 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, or 21 days for fodder. REI 2 days. Do not exceed 2.25 lb ai/a or 5 treatments per season. Retreatment interval 5 to 7 days.
- ◆ tebuconazole/lambda-cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ zeta-cypermethrin (Mustang) at 0.034 to 0.05 lb ai/a. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 3 days.

Field and silage corn—Armyworm

Includes

Armyworm (*Pseudaletia unipuncta*)

Beet armyworm (*Spodoptera exigua*)

Pest description and crop damage Mature larvae are 1.5 inches long. Color varies from brown (armyworm) to green. Moths occasionally are attracted to weeds in corn fields.

Management—chemical control

For best results, apply treatments when armyworms are small to medium size (0.25 to 0.75 inch).

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 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. Use according to individual manufacturer's label instructions. OMRI-listed for organic use.
- ◆ beta cyfluthrin (Baythroid XL) at 0.013 to 0.022 lb ai/a. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed four applications or 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC, Sniper, Capture LFR) at 0.033 to 0.1 lb ai/a foliar, 0.04 lb ai/a preemergence, or 0.047 to 0.062 lb ai/a preplant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season. Do not apply Capture LFR as foliar treatment.
- ◆ bifenthrin/indol butyric acid (Empower 2) at 0.04 to 0.1 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/a including foliar and at planting.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a foliar or at planting. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ *Burkholderia* spp. (Venerate XC) at 1 to 8 qt/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days for forage or silage grazing, and 48 days for grain harvest. REI 24 hr. Do not exceed four applications or 8 lb ai/a per season. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.059 to 0.098 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 14 days. REI 4 hr. Do not exceed 4 treatments or 0.2 lb ai/a per season. Retreatment interval 7 days.

- ◆ chlorpyrifos—
 - Lorsban 15G at 0.056 to 0.075 lb ai/1,000 row ft (post-plant). PHI 21 days. REI 24 hr. Do not exceed 0.15 lb ai/1,000 row ft or 3 lb ai/a per season. Apply as a band or treatment.
 - Lorsban Advanced at 0.47 to 0.94 lb ai/a post emergence broadcast. Chemigation permitted. PHI 21 days grain, ears, forage or fodder. REI 24 hr. Limit 3 treatments. Do not exceed 3 lb ai/a per season.
- ◆ *Chromobacterium subsugae* (Grandevo) at 0.3 - 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 for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/a per season.
- ◆ deltamethrin (Delta Gold) at 0.018 to 0.022 lb ai/a. PHI 21 days for grain or fodder, and 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/a per season. Retreatment interval 21 days. Limit 5 treatments per year.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- ◆ flubendiamide (Belt SC) at 0.0625 to 0.094 lb ai/a. PHI green forage and silage 1 day; grain and stover 28 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.375 lb ai/a per season or 4 treatments.
- ◆ gamma cyhalothrin (Declare) at 0.015 lb ai/a. Effective on first and second instar larvae only. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- ◆ GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.8 lb ai/a. PHI 0 day. REI 4 hr. Do not exceed 2 lb ai/a per year.
- ◆ indoxacarb (Steward EC) at 0.059 to 0.11 lb ai/a. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 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 apply more than 0.12 lb ai/a per season, 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after milk stage.
- ◆ methomyl (Lannate SP) at 0.22 to 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, 21 days for fodder. REI 48 hr. Do not exceed 2.25 lb ai/a or 5 treatments per season. Retreatment interval 5 to 7 days.
- ◆ methoxyfenozide (Intrepid 2F) at 0.06 to 0.25 lb ai/a. PHI 21 days. Do not exceed 1 lb ai/a per season. REI 4 hr.
- ◆ methoxyfenozide/spinetoram (Intrepid Edge) at 0.094 to 0.281 lb ai/a. PHI 28 days. REI 4 hr. Do not exceed 0.625 lb ai methoxyfenozide and 0.125 lb ai spinetoram per acre per year. Limit 3 treatments. Retreatment interval 4 days except 2 days for silking.
- ◆ permethrin—
 - Ambush 25W at 0.1 to 0.2 lb ai/a foliar or as preemergent. PHI 0 days for forage; 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/a per season.
 - Loveland Permethrin Cutworm Bait at 0.1 to 0.15 lb ai/a. REI 12 hr. PHI 0 days for forage; 30 days for grain harvest or fodder. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
 - Pounce 1.5G at 0.0075 to 0.015 lb ai/1,000 row ft soil or 0.1 to 0.15 lb ai/a broadcast. PHI 0 days for forage; 30 days for grain harvest or fodder (stover). REI 12 hr. Apply in furrow or as band at planting. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- ◆ spinetoram (Radiant SC) at 0.023 to 0.047 lb ai/a. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/a per year. Do not exceed 3 treatments. Retreatment interval 4 days.

- ◆ spinosad (Success) at 0.023 to 0.094 lb ai/a. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/a per season.
- ◆ tebuconazole/lambda-cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 7 days for grain, stover and forage. Apply no more than 0.2 lb ai/a per season. Retreatment interval 3 days.

Field and silage corn—Corn earworm

Helicoverpa zea

Pest description and crop damage Large green, brown, or yellow worms that feed within silk and ears. First-generation larvae may feed as “bud worms,” damaging leaf whorls and newly forming ears.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC) at 0.011 to 0.025 lb ai/a. REI 12 hr. PHI 30 days grain and stover; 60 days forage. 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 for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed four applications or 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC, Sniper) at 0.033 to 0.1 lb ai/a. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ *Burkholderia* spp. (Venerate XC) at 1 to 8 qt/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days for forage or silage grazing, and 48 days for grain harvest. REI 24 hr. Do not exceed four applications or 8 lb ai/a per season. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.049 to 0.098 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 14 days. REI 4 hr. Do not exceed 4 treatments nor 0.2 lb ai/a per season. Retreatment interval 7 days.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.7 to 0.94 lb ai/a. PHI 21 days before harvest of grain or ears. REI 24 hr. Apply as a broadcast spray. Do not exceed 3 lb ai/a per season for all chlorpyrifos 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.
- ◆ cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/a per season.
- ◆ deltamethrin (Delta Gold) at 0.018 to 0.022 lb ai/a. PHI 21 days for grain or fodder, or 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/a per season. Retreatment interval 21 days. Limit 5 treatments per year.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- ◆ flubendiamide (Belt SC) at 0.0625 to 0.094 lb ai/a. PHI green forage and silage 1 day; grain and stover 28 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.375 lb ai/a per season or 4 treatments.

- ◆ gamma cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a. Effective prior to larvae entering the ear only. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- ◆ HZNPV (Gemstar LC)—Insecticidal virus product. OMRI-listed for organic use.
- ◆ indoxacarb (Steward EC) at 0.059 to 0.11 lb ai/a. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 lb ai/a per year.
- ◆ lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/a per season, 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after milk stage.
- ◆ methomyl (Lannate SP) at 0.22 to 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, 21 days for fodder. Do not exceed 2.25 lb ai/a or 5 treatments per season. REI 48 hr. Retreatment interval 5 to 7 days.
- ◆ methoxyfenozide/spinetoram (Intrepid Edge) at 0.188 to 0.281 lb ai/a. PHI 28 days. REI 4 hr. Do not exceed 0.625 lb ai methoxyfenozide and 0.125 lb ai spinetoram per acre per year. Limit 3 treatments. Retreatment interval 4 days except 2 days for silking.
- ◆ permethrin (Ambush 25W) at 0.1 to 0.2 lb ai/a. PHI 0 days for forage; 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between treatments. Do not apply more than 0.6 lb ai/a per season.
- ◆ spinetoram (Radiant SC) at 0.023 to 0.047 lb ai/a. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/a per year. Do not exceed 3 treatments. Retreatment interval 4 days.
- ◆ spinosad (Success) at 0.047 to 0.094 lb ai/a. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/a per season. OMRI-listed for organic use.
- ◆ *Spodoptera frugiperda* MNPV-3AP2 (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 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 7 days for grain, stover and forage. Do not exceed 0.2 lb ai/a per season. REI 12 hr. Retreatment interval 3 days.

Field and silage corn—Corn rootworm

Diabrotica spp.

Pest description and crop damage West of the Cascades *D. undecimpunctata* is most common; east of the Cascades *D. virgifera* is common. Mature larva is 0.5 inch long, pale yellow, with a brown head and dorsal anal plate. Larvae feed on and mine into corn roots causing stunting and lodging of plants and stand reduction.

Management—cultural control

Crop rotation helps to reduce infestations from *D. virgifera* as eggs overwinter in soil. The adults of *D. undecimpunctata* overwinter, therefore crop rotation is not as important in managing this species.

Management—chemical control

Seed treatments

- ◆ abamectin/thiamethoxam (Avicta Duo Corn)—Requires tank mix. Apply as slurry to corn seed. Consult label.
- ◆ clothianidin (Poncho 600) at 1.25 mg ai/kernel or 0.22 lb ai/80,000 seed unit. Commercial treaters only.
- ◆ imidacloprid (Gaucho 600)—Refer to label for planter box treatment. REI 24 hr.
- ◆ thiamethoxam (Cruiser 5FS) at 1.25mg ai/kernel.

Larvae treatments

- ◆ bifenthrin/indol butyric acid (Empower 2) at 0.005 to 0.006 lb ai/1,000 row ft. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/a foliar and at planting.
- ◆ *Bt/Diabrotica virgifera* (Smartstax Pro Enlist). Refer to label instructions.
- ◆ chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.2 to 0.25 oz ai/1,000 row ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in-furrow. Apply with Smartbox system. Do not exceed one application per year.
- ◆ chlorpyrifos—
 - Lorsban 15G at 0.075 lb ai/1,000 row ft. PHI 21 days. REI 24 hr. Do not exceed 3 lb ai/a per season. Apply at planting as a band or at cultivation as a band or side-dress.
 - Lorsban Advanced at 0.94 lb ai/a post emergence broadcast. Chemigation permitted. PHI 21 days grain, ears, forage or fodder. REI 24 hr. Limit 3 treatments. Do not exceed 3 lb ai/a per season.
- ◆ *Chromobacterium subsugae* (Grandevo) at 0.05 to 0.1 lb ai/a per 1,000 row feet. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ ethoprop (Mocap 15G) at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- ◆ gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft at planting. REI 24 hr. Do not exceed 0.045 lb ai/acre at plant and 0.06 lb ai/a per season.
- ◆ lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 row ft (planting). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai/a from at plant and foliar applications.
- ◆ phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft at plant or cultivation, broadcast or banded but not in-furrow. PHI 30 days to cutting or forage. REI 48 hr. Use only once per season.
- ◆ tefluthrin (Force 3G) at 0.0075 to 0.094 lb ai/1,000 row ft. REI 0 hr. T-band or in-furrow at planting. Do not exceed 0.327 lb ai/a per year. Use only once per season.
- ◆ terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. Do not exceed 1.3 lb ai/a per season. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. May be side-dressed at cultivation time if preplant treatment was not made. To be effective, apply before corn is 12 inches high.

Adult treatments

- ◆ alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. REI 12 hr. PHI 30 days grain and stover; 60 days forage. 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 for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed four applications or 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season. Rootworm adults only.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ carbaryl (Sevin 4F) at 1 to 2 lb ai/a. PHI 14 days for forage or silage, 48 days for grain or fodder. REI 24 hr. Do not exceed four applications or 8 lb ai/a per season. Re-treat every 14 days. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.059 to 0.098 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.

- ◆ chlorpyrifos (Lorsban Advantage) at 0.47 to 0.94 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 3 lb ai/a per season. Apply as a postemergence broadcast spray or through overhead sprinklers.
- ◆ *Chromobacterium subsugae* (Grandevo) at 0.6 - 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 for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/a per season.
- ◆ deltamethrin (Delta Gold) at 0.018 to 0.022 lb ai/a. PHI 21 days for grain or fodder, or 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/a per season. Retreatment interval 21 days. Limit 5 treatments per year.
- ◆ dimethoate (Dimethoate 400) at 0.33 to 0.5 lb ai/a. PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Do not apply if bees are foraging actively.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
- ◆ GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year.
- ◆ indoxacarb (Steward EC) at 0.059 to 0.11 lb ai/a. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 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 apply more than 0.12 lb ai/a per season, 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after milk stage.
- ◆ malathion (Gowan Malathion 8, Fyfanon 8) at 0.6 to 1 lb ai/a. PHI 5 days. REI 12 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- ◆ methomyl (Lannate SP) at 0.22 to 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, and 21 days for fodder. REI 48 hr. Do not exceed 2.25 lb ai/a or 5 treatments per season. Retreatment interval 5 to 7 days.
- ◆ permethrin (Ambush 25W) at 0.1 to 0.2 lb ai/a. PHI 0 days for forage, 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/a per season.
- ◆ tebuconazole/lambda-cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ zeta-cypermethrin (Mustang) at 0.034 to 0.05 lb ai/a. PHI 7 days for grain, stover and forage. Do not exceed 0.2 lb ai/a per season. REI 12 hr. Retreatment interval 3 days.
- ◆ bifenthrin (Brigade 2EC, Sniper, Capture LFR) at 0.033 to 0.1 lb ai/a foliar, 0.0023 to 0.0046 lb ai/1,000 row ft at plant, 0.047 to 0.062 lb ai/a preplant incorporated, or 0.04 lb ai/a preemergence. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season. Do not apply Capture LFR as foliar treatment.
- ◆ bifenthrin/indol butyric acid (Empower 2) at 0.002 to 0.006 lb ai/1,000 row ft. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/a foliar and at planting.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.025 to 0.06 lb ai/a foliar or at plant at 0.04 to 0.1 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ carbaryl (Sevin 4F, Sevin 5 Bait) bait or spray at 2 lb ai/a. PHI 14 days for harvest or grazing forage or silage, and 48 days for grain or fodder harvest. REI 24 hr. Do not exceed four applications per season. Early season applications when plants are 6 to 12 inches high should be directed to the lower stalk portions and soil around the plant bases. Do not use if bees are foraging actively in the field.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.049 to 0.098 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- ◆ chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.15 to 0.175 oz ai/1,000 row ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in-furrow. Apply with Smartbox system. Do not exceed one application per year.
- ◆ chlorpyrifos—
 - Lorsban 15G at 0.075 lb ai/1,000 row ft banded at planting or in-furrow. PHI 21 days. REI 24 hr. Do not exceed 0.15 lb ai/1,000 row ft or 3 lb ai/a per season.
 - Lorsban Advanced at 0.47 to 0.94 lb ai/a pre and post emergence broadcast. Shallow incorporation improves control Chemigation permitted. PHI 21 days grain, ears, forage or fodder. REI 24 hr. Limit 3 treatments. Do not exceed 3 lb ai/a per season.
- ◆ cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/a of cyantraniliprole products per year.
- ◆ cyfluthrin (Tombstone) at 0.013 to 0.025 lb ai/a. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/a per season.
- ◆ deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/a. PHI 21 days for grain or fodder or 12 days for forage or grazing. REI 12 hr. Re-treatment interval is 21 days. Do not exceed 0.095 lb ai/a per season. Retreatment interval 21 days. Limit 5 treatments per year.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a foliar or 0.0023 lb per 1,000 row ft at plant. PHI 21 days. REI 12 hr.
- ◆ ethoprop (Mocap 15G) at 3.0 lb ai/a broadcast three days before planting to planting time. REI 48 hr or 72 hr where annual rain is less than 25 inches. One application per season. Mix with the top two inches of soil.
- ◆ flubendiamide (Belt SC) at 0.0625 to 0.094 lb ai/a. PHI green forage and silage 1 day; grain and stover 28 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.375 lb ai/a per season nor 4 treatments.
- ◆ gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft at plant; 0.0075 to 0.0125 lb ai/a foliar application. PHI 1 day for grazing and forage, or 21 days for fodder or silage. REI 24 hr. Do not exceed 0.06 lb ai/a per season.

Field and silage corn—Cutworm

Includes

Black cutworm (*Agrotis ipsilon*)

Western bean cutworm (*Loxagrotis albicosta*)

Pest description and crop damage Brown to black larvae up to 1.5 inches at maturity. They clip seedlings and tunnel into the bases of older plants. Larvae are usually in soil at planting.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC) at 0.008 to 0.018 lb ai/a or 0.001 lb ai/1,000 row ft as in furrow, band or T-band. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/a per season.
- ◆ azadirachtin (Neemix 4.5)—PHI 0 days. REI 12 hr. See label for rates. Slow acting. Apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/a. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.088 lb ai/a per season.

- ◆ lambda-cyhalothrin (Warrior II) at 0.015 to 0.025 lb ai/a foliar or 0.005 lb ai/1,000 row ft at planting. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/a at plant and foliar applications per season, 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after milk stage.
- ◆ methomyl (Lannate SP) at 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, 21 days for fodder. Do not exceed 2.25 lb ai/a or 5 treatments per season. Retreatment interval 5 to 7 days.
- ◆ methoxyfenozide (Intrepid 2F) at 0.06 to 0.25 lb ai/a. PHI 21 days. REI 4 hr. Do not exceed 1 lb ai/a per season. Western bean cutworm only.
- ◆ permethrin—
 - Ambush 25W at 0.1 to 0.2 lb ai/a foliar or as preemergent. PHI 0 days for forage harvest or 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/a per season.
 - Loveland Permethrin Cutworm Bait at 0.1 to 0.15 lb ai/a. REI 12 hr. PHI 0 days for forage; 30 days for grain harvest or fodder. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
 - Pounce 1.5G at 0.0075 to 0.015 lb ai/1,000 row ft soil or 0.1 to 0.15 lb ai/a broadcast. Apply in furrow or as band at planting. PHI 0 days for forage harvest or 30 days for grain harvest or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per season.
- ◆ spinetoram (Radiant SC) at 0.023 to 0.047 lb ai/a. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/a per year. Do not exceed 3 treatments. Retreatment interval 4 days. Western bean cutworm only.
- ◆ spinosad (Success) at 0.047 to 0.094 lb ai/a. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/a per season. OMRI-listed for organic use. Western bean cutworm only.
- ◆ tebuconazole/lambda-cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ tefluthrin (Force 3G) at 0.0056 to 0.075 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0.
- ◆ terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Do not exceed 1.3 lb ai/a per season. Band or furrow at planting.
- ◆ zeta-cypermethrin (Mustang) at 0.016 to 0.035 lb ai/a foliar. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/a per season.

Seed treatments

- ◆ abamectin/thiamethoxam (Avicta Duo Corn)—Apply as slurry to corn seed. Consult label.
- ◆ clothianidin (Poncho)—Commercial treaters only. See label instructions.
- ◆ clothianidin/*Bacillus firmus* (Poncho Votivo) at 0.5 mg ai/seed. Do not exceed 0.5 mg ai/seed.
- ◆ thiamethoxam/abamectin/azoxystrobin (Avicta Complete). Refer to label instructions.

Field and silage corn—Garden symphylan

Scutigera immaculata

Pest description and crop damage Small, white, centipede-like animals with 6 to 12 pairs of legs, rapidly vibrating antennae, and two short projections at rear end. They prune rootlets, feed on root hairs, reduce stands and plant vigor, and can delay harvest in heavily infested plant roots.

Management—chemical control

- ◆ chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.15 to 0.175 oz ai/1,000 row ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- ◆ chlorpyrifos (Lorsban 15G) at 0.075 lb ai/1,000 row ft at planting. Apply as a band treatment over the row at planting and incorporate to 0.5 to 1 inch. PHI 21 days. REI 24 hr. Do not exceed 0.15 lb/1,000 row ft or 2 lb ai/a per season.
- ◆ ethoprop (Mocap 15G) at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- ◆ terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Do not exceed 1.3 lb ai/a per season. Band or furrow at planting. Refer to label for aquatic advisory.

See also:

Biology and Control of Garden Symphylan

Field and silage corn—Grasshopper

Several species

Pest description and crop damage Have caused extensive defoliation during some years.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC) at 0.017 to 0.025 lb ai/a. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/a per season.
- ◆ azadirachtin (Neemix 4.5)—PHI 0 days. REI 12 hr. See label for rates. Slow acting. Apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.017 to 0.022 lb ai/a. PHI 0 days for green forage and 21 days for fodder or grain. REI 12 hr. Do not exceed 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC) at 0.033 to 0.1 lb ai/a. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season.
- ◆ bifenthrin/zeta-cypermethrin (Hero) at 0.025 to 0.06 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ carbaryl (Sevin 5 Bait) at 2 lb ai/a. PHI 14 days for forage or silage or 48 days for grain or fodder. REI 24 hr. Do not exceed four applications per season. Retreatments every 14 days.
- ◆ chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/a. PHI 14 days. REI 4 hr. Do not exceed 4 treatments nor 0.2 lb ai/a per season. Retreatment interval 7 days.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Besiege) at 0.059 to 0.098 lb ai/a. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- ◆ cyfluthrin (Tombstone) at 0.033 to 0.044 lb ai/a. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/a per season.

- ◆ deltamethrin (Delta Gold) at 0.012 to 0.018 lb ai/a. PHI 21 days for grain or fodder or 12 days for forage or grazing. REI 12 hr. Retreatment interval is 21 days. Do not exceed 0.095 lb ai/a per season. Limit 5 treatments per year.
- ◆ dimethoate (Dimethoate 400) at 0.5 lb ai/a. PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/a per season.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 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 for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/a per season.
- ◆ indoxacarb (Steward EC) at 0.059 to 0.11 lb ai/a. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 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 apply more than 0.12 lb ai/a per season, 0.06 lb ai/a after silk initiation, or 0.03 lb ai/a after milk stage.
- ◆ malathion (Gowan Malathion 8, Fyfanon 8) at 0.6 to 1 lb ai/a. PHI 5 days. REI 12 hr. Limit 2 treatments per year. Retreatment interval 7 days.
- ◆ tebuconazole/lambda-cyhalothrin (Crossover) at 0.14 to 0.16 lb ai/a. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/a tebuconazole or 0.12 lb ai/a lambda-cyhalothrin per season.
- ◆ zeta-cypermethrin (Mustang) at 0.034 to 0.05 lb ai/a. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Retreatment interval 3 days.

Field and silage corn—Mite

Tetranychus spp.

Pest description and crop damage Tiny eight-legged animals that feed on the lower surface of leaves. They cause yellowing and silvering of plants. They may cause early maturity and reduced quality. Usually they do not cause economic damage.

Management—chemical control

- ◆ bifenthrin (Brigade 2EC) at 0.08 to 0.1 lb ai/a. PHI 30 days for grain harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/a per season.
- ◆ bifenthrin/zeta-cypermethrin (Hero) at 0.1 lb ai/a. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 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.
- ◆ dimethoate (Dimethoate 400) at 0.33 to 0.5 lb ai/a. PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Do not use during pollen shed.
- ◆ etoxazole (Zeal SC) at 0.045 to 0.135 lb ai/a. PHI 21 days. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments per year. Do not exceed 0.27 lb ai/a per season.
- ◆ hexythiazox (Onager) at 0.078 to 0.188 lb ai/a. PHI 30 days. REI 12 hr. One treatment per year.
- ◆ phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft, broadcast or banded but not in-furrow. PHI 30 days graze or forage. REI 48 hr. Limit 1 application per season.
- ◆ propargite (Comite) at 1.64 to 2.46 lb ai/a. PHI 30 days. REI 13 days. Apply when corn leaves are dry. Use a minimum of 5 gallons spray solution per acre. One treatment per year.
- ◆ propylene glycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- ◆ spiromesifen (Oberon 2SC) at 0.09 to 0.25 lb ai/a. PHI 5 days for green forage and silage; 30 days for grain or stover. REI 12 hr. Apply with a minimum of 10 gallons by ground or 5 gallons by air.

Limit 2 treatments per year. Do not exceed 0.27 lb ai/a per season. See label for chemigation.

- ◆ sulfur at 6 to 15 lb ai/a for spider mite suppression. REI 24 hr.

Field and silage corn—Seedcorn maggot

Delia platura

Pest description and crop damage A small white maggot that attacks germinating seeds. Kills seedlings and reduces stands, occasionally so severely that they need replanting. Damage is most severe when corn is planted early in the season, and germination and seedling emergence are delayed.

Management—chemical control

Typically, best and most economic control is achieved with insecticide-treated seed.

- ◆ beta-cyfluthrin (Baythroid XL) at 0.015 to 0.02 oz ai/1,000 row ft. PHI 0 days for forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC, Sniper, Capture LFR) at 0.0023 to 0.0046 lb ai/1,000 row ft over open seed furrow; 0.047 to 0.062 lb ai/a pre-plant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not exceed 0.1 lb ai/a per season as an at plant application. Do not apply Capture LFR as foliar treatment.
- ◆ bifenthrin/indol butyric acid (Empower 2) at 0.002 to 0.006 lb ai/1,000 row ft in furrow. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/a foliar and at planting.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a in furrow. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.2 to 0.25 oz ai/1,000 row ft. REI 2 days, or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- ◆ chlorpyrifos (Lorsban 15G) at 0.075 lb ai/1,000 row ft at planting. Apply as a band or an in-furrow treatment at planting. PHI 21. REI 24 hr. Do not exceed 0.15 lb ai/1,000 row ft or 2 lb ai/a per season.
- ◆ cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/a of cyantraniliprole products per year.
- ◆ cyfluthrin (Tombstone) at 0.03 to 0.04 oz ai/1,000 row ft. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.175 lb ai/a per season.
- ◆ gamma-cyhalothrin (Declare) at 0.0025 lb ai/1,000 row ft at planting. REI 12 hr. Do not exceed 0.06 lb ai/a from at plant and foliar treatments.
- ◆ lambda-cyhalothrin (Warrior II) at 0.005 lb/1,000 row ft. 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/a per season at plant or foliar applications.
- ◆ permethrin (Loveland Permethrin) at 0.1 to 0.15 lb ai/a pre-plant incorporated, pre-emergence or at planting. PHI 0 days for forage, 30 days for grain harvest or fodder (stover). REI 12 hr. As preemergent, apply from 5 days before planting up to crop emergence. Apply in furrow or as band at planting.
- ◆ phorate (Thimet 20G) 0.056 to 0.075 lb ai/1,000 row ft at planting or cultivation, broadcast or banded but not in-furrow. REI 48 hr. Limit one application.
- ◆ tefluthrin (Force 3G) at 0.0075 to 0.0094 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0 hr. Do not exceed 0.327 lb ai/a per year. Use only once per season.
- ◆ terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Band or furrow at planting.

Seed treatments

- ◆ abamectin/thiamethoxam (Avicta Duo Corn)—Apply as slurry to corn seed. Consult label.
- ◆ abamectin/thiamethoxam/azoxystrobin (Avicta Complete)—Refer to label for instructions.
- ◆ chlorpyrifos (Lorsban 50W) seed treatment at 1 oz ai/100 lb seed. Use as slurry treatment before planting.
- ◆ clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel. Commercial treaters only.
- ◆ clothianidin/*Bacillus firmus* (Poncho Votivo) at 0.5 mg ai/seed. Do not exceed 0.5 mg ai/seed.
- ◆ imidacloprid/carboxin/metalaxyl (Latitude Seed Treatment) at 1.5 oz product per 42 lb of seed. Use as a dry mixture in the planter box as a seed treatment prior to planting. See label for complete instructions. REI 24 hr.
- ◆ imidacloprid (Gaucho 600)—Refer to label. REI 24 hr.
- ◆ permethrin/carboxin (Kernel Guard Supreme) at 1.5 oz canister per 42 lb seed. Apply to seed at planting time with canister applicator tube system. REI 12 hr. Do not graze or feed livestock on treated areas for six weeks after planting.
- ◆ thiamethoxam (Cruiser 5FS). Commercial treaters only. See label instructions.

Field and silage corn—Slug

Gray garden slug (*Deroceras reticulatum*) is one of the most common species.

Pest description and crop damage Land mollusks that feed on various plants, damaging roots, crowns, leaves, and fruit.

Management—chemical control

- ◆ metaldehyde baits at 1.2 to 2.4 lb ai/a. PHI 30 days.
- ◆ iron phosphate (Sluggo) at 0.5 to 1.0 lb ai/1,000 sq ft.

Field and silage corn—Wireworm

Ctenicera and *Limonius* spp.

Pest description and crop damage Brown, jointed larvae of click beetles. Wireworms cause problems most often when a corn crop follows turf or pasture. Larvae attack seed, weaken and kill seedlings, and reduce stands.

Management—cultural control

Plowing deeply and using treated seed and insecticides are important management tools for these pests.

Management—chemical control

- ◆ beta-cyfluthrin (Baythroid XL) at 0.015 to 0.02 oz ai/1,000 row ft. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.088 lb ai/a per season.
- ◆ bifenthrin (Brigade 2EC, Capture LFR) at 0.0023 to 0.0046 lb ai/1,000 row ft at plant; or 0.047 to 0.062 lb ai/a preplant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not exceed 0.1 lb ai/a at planting or 0.3 lb ai/a per season. Do not apply Capture LFR as foliar treatment.
- ◆ bifenthrin/indol butyric acid (Empower 2) at 0.002 to 0.006 lb ai/1,000 row ft. PHI 30 days in furrow. REI 24 hr. Do not exceed 0.3 lb ai/a foliar and at planting.
- ◆ bifenthrin/zeta-cypermethrin (Hero EW) at 0.04 to 0.1 lb ai/a in furrow. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.4 lb ai/a per season.
- ◆ chlorethoxyfos/bifenthrin (Smart Choice 5G) at 0.2 to 0.25 oz ai/1,000 row ft. REI 2 days or 3 days where annual rainfall is less

than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.

- ◆ chlorpyrifos (Lorsban 15G) at 0.075 lb ai/1,000 row ft. PHI 21 days. REI 24 hr. Do not exceed 0.15 lb ai/1,000 row ft or 2 lb ai/a per season. Apply at planting either as a band treatment over the row incorporated to 1 inch or as an in-furrow treatment.
- ◆ cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/a of cyantraniliprole products per year.
- ◆ cyfluthrin (Tombstone) at 0.03 to 0.04 oz ai/1,000 row ft. PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.175 lb ai/a per season
- ◆ ethoprop (Mocap 15G) at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- ◆ gamma-cyhalothrin (Declare) at 0.0004 lb ai/1,000 row ft at plant. PHI 21 days. REI 24 hr. Do not exceed 0.06 lb ai/a from at plant and foliar treatments.
- ◆ lambda-cyhalothrin (Warrior II) at 0.005 lb ai/1,000 row ft (planting). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai/a from at plant and foliar applications.
- ◆ permethrin (Loveland Permethrin) at 0.1 to 0.15 lb ai/a pre-plant or at plant. PHI 0 days for forage, 30 days for grain harvest or fodder (stover). REI 12 hr. As preemergent, apply from 5 days before planting up to crop emergence. Apply in furrow or as band at planting.
- ◆ phorate (Thimet 20G) 0.056 to 0.075 lb ai/1,000 row ft at planting or cultivation, broadcast or banded but not in-furrow. REI 48 hr. Limit one application.
- ◆ tefluthrin (Force 3G) at 0.0075 to 0.0094 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0. Do not exceed 0.327 lb ai/a per year. Use only once per season.
- ◆ terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Band or furrow at planting.

Seed treatments

- ◆ abamectin/thiamethoxam (Avicta Duo Corn)—Apply as slurry to corn seed. Consult label.
- ◆ abamectin/thiamethoxam/azoxystrobin (Avicta Complete)—Refer to label for instructions.
- ◆ clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel or 0.22 lb ai/80,000 seed unit. Commercial treaters only.
- ◆ clothianidin/*Bacillus firmus* (Poncho Votivo) at 0.5 mg ai/seed. Do not exceed 0.5 mg ai/seed.
- ◆ imidacloprid/carboxin/metalaxyl (Latitude Seed Treatment) at 1.5 oz product per 42 lb of seed. Use as a dry mixture in the planter box as a seed treatment prior to planting. See label for complete instructions. REI 24 hr.
- ◆ imidacloprid (Gaucho 600)—Refer to label for planter box treatment. REI 24 hr.
- ◆ permethrin/carboxin (Kernel Guard Supreme) at 1.5 oz canister per 42 lb seed. Apply to seed at planting time with canister applicator tube system. REI 12 hr. Do not graze or feed livestock on treated areas for six weeks after planting.
- ◆ thiamethoxam (Cruiser 5FS)—Commercial seed treaters only. See label instructions.

See also:

Potato, Irish—Wireworm

Hop Pests

Doug Walsh

Latest revision—March 2020

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.

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

Hop—Armyworm

Includes *bertha armyworm* (*Mamestra configurata*)

Pest description and crop damage Caterpillars are mostly dark green to black with thin white lines down the back and a light brown head. A white to yellow lateral band runs the length of the body.

Management—chemical control

- ◆ abamectin/bifenthrin (Athena) by ground for armyworms except beet armyworm at 0.068 to 0.11 lb ai/a. PHI 28 days. REI 12 hr. Do not make more than two applications of Athena per season. Do not make applications less than 21 days apart. Do not apply more than 0.019 lb ai/a of any abamectin formulation or 0.30 lb ai/a of any bifenthrin formulation per season. Group 6/3A insecticides.
- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum application interval is 21 days. Group 3A insecticide.
- ◆ Burkholderia spp. strain A396. (Venerate XC)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ chlorantraniliprole (Coragen) for western yellowstriped armyworm at 0.045 to 0.065 lb ai/a. PHI 0 days. REI 4 hr. Up to four applications per year at 7-day intervals. Do not exceed 15.4 fl oz or 0.2 lb ai/a chlorantraniliprole-containing product per year. Group 28 insecticide.
- ◆ *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air for armyworms except beet armyworm at 0.20 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.

- ◆ naled (Dibrom 8E) at 0.9 lb ai/a. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. Apply in 100 to 200 gallons of water by air or 10 to 20 gallons of water by ground. Group 1B insecticide.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ spinetoram (Delegate WG) at 0.039 to 0.063 lb/ai. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai per season. Group 5 insecticide.
- ◆ spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/a. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/a per season. Some formulations are OMRI-listed for organic use. Group 5 insecticide.

Hop—Corn earworm

Helicoverpa zea

Pest description and crop damage Caterpillars vary from green to brown or reddish, with a few fine hairs or spines on the body.

Management—chemical control

- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.

Hop—Cutworm

Several species

Pest description and crop damage Soil-dwelling caterpillars. Their color varies, but mostly it is dark with distinct dorsal markings. Skin is smooth and glassy.

Management—chemical control

- ◆ abamectin/bifenthrin (Athena) by ground for armyworms except beet armyworm at 0.068 to 0.11 lb ai/a. PHI 28 days. REI 12 hr. Do not make more than two applications of Athena per season. Do not make applications less than 21 days apart. Do not apply more than 0.019 lb ai/a of any abamectin formulation or 0.30 lb ai/a of any bifenthrin formulation per season. Group 6/3A insecticides.
- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum interval between applications is 21 days. Group 3A insecticide.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a

of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.

- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/a. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/a per season. Group 5 insecticide.
- ◆ spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/a. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/a per season. Some formulations are OMRI-listed for organic use.. Group 5 insecticide.

Hop—European earwig

Forficula auricularia

Pest description and crop damage Mature forms are about 0.6 inch long and light to dark brown. They are identified easily by the strong, movable, forceps-like cerci at the posterior tip of the abdomen. They don't damage plants, but their presence can contaminate harvested crops.

Management—chemical control

- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.

Hop—Garden symphylan

Scutigera immaculata

Pest description and crop damage A pest in western Oregon. Small, white-bodied, centipede-like animals. Adults have 12 pairs of legs, rapidly vibrating antenna, and spinnerets on the posterior of the body. They feed on roots and above-ground plant parts in contact with soil.

Management—chemical control

- ◆ ethoprop (Mocap EC) at 3 lb ai/a on baby hops (nonproducing) or producing hops. REI 72 hr. Group 1B insecticide.
 - *Baby hops, post-plant, pre-emergence*: apply as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row.
 - *Baby hops, pre-plant*: apply as a broadcast application and immediately incorporate into the top 2 to 4 inches of soil using a disc or rotary cultivator.
 - *Producing hops*: apply in the spring after pruning, but before stringing, or post-harvest as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row. PHI 90 days. Make only one application per year. Do not apply more than 3.0 lb ai/a per year. Do not apply to

saturated soils which increases runoff or to dry soils which decreases effectiveness.

- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ thiamethoxam (Platinum) at 0.125 lb ai/a. PHI 65 days. REI 12 hr. Do not exceed 0.125 lb ai/a per season. Apply (1) to the soil as a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Group 4A insecticide.

See also:

Biology and Control of the Garden Symphylan

Hop—Hop aphid

Phorodon humuli

Pest description and crop damage Aphids overwinter as eggs on prune trees. Greenish to black, winged forms migrate to hops in May or June. Wingless forms on hops are pale yellowish green. They suck plant juices and contaminate cones.

Management—chemical control

- ◆ *Beauveria bassiana* (Botanigard ES, Mycotrol 0)—See label for rates. PHI 0 days. REI 4 hr. Apply when pests first appear. Repeat applications as needed. Some formulations are OMRI-listed for organic use.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum interval between applications is 21 days. Group 3A insecticide.
- ◆ *Burkholderia* spp. strain A396. (Venerate XC)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ *Chromobacterium subsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ cyfluthrin (various formulations) at 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not apply more than five times per crop season. Do not apply more than 0.125 lb ai/a per season of any formulation of cyfluthrin. Allow at least 14 days between applications. Group 3A insecticide.
- ◆ fonicamid (BeLeaf 50SG) at 0.054 to 0.089 lb ai/a. PHI 10 days. REI 12 hr. Do not make more than three applications per season. Do not apply more than 0.089 lb ai/a per application or 0.267 lb ai/a per season. Group 9C insecticide
- ◆ flupyradifurone (Sivanto 200 SL) at 0.09 to 0.137 lb ai/a. PHI 21 days. REI 12 hr. Apply in a minimum of 25 gal per acre (ground) or 10 gal per acre (aerial). Do not apply more than 0.137 lb per acre per year. Group 4D insecticide.
- ◆ imidacloprid (various formulations) to the soil at 0.3 lb ai/a. PHI 60 days. PHI 12 hr. One application to the soil per season applied as (1) a drip irrigation, (2) a subsurface side dress shank irrigation, or (3) a hill drench. Follow side dress and shank applications by furrow or sprinkler irrigations to ensure incorporation into the root zone. Do not apply more than 0.3 lb ai/a per season of any imidacloprid formulation. Group 4A insecticide.
- ◆ imidacloprid (various formulations) by ground or air at 0.1 lb ai/a. PHI 28 days. REI 12 hr. Allow at least 21 days between applications. Do not apply more than 0.3 lb ai/a per season of imidacloprid formulation. Group 4A insecticide.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air

at 0.06 to 0.20 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.

- ◆ imidacloprid/cyfluthrin (Leverage 2.7) by ground or air at 0.12 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.25 lb ai/a of any cyfluthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ imidacloprid/beta-cyfluthrin (Leverage 360) by ground or air at 0.075 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.125 lb ai/a of any beta-cyfluthrin formulation, more than 0.250 lb ai/a of any beta-cyfluthrin/cyfluthrin formulation or more than 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ malathion (various formulations) at 0.5 to 1.25 lb ai/a. See label for rates. PHI 7 to 10 days; check label. REI 12 hr. Group 1B insecticide.
- ◆ naled (Dibrom 8E) at 0.9 lb ai/a. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. Group 1B insecticide.
- ◆ potassium salts of fatty acids (M-pede)—PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pymetrozine (Fulfill) at 0.125 to 0.188 lb ai/a. PHI 14 days. Apply before aphids reach damaging levels. Do not apply at lower than recommended rates. Do not apply by air. Do not apply more than 0.188 lb ai per application. Do not exceed 0.56 lb ai per season. Allow at least 14 days between applications. Group 9B insecticide.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ spirotetramat (Movento, Ultor) at 0.08 to 0.096 lb ai/a. PHI 7 days. REI 4 hr. Allow at least 14 days between applications. Do not apply more than 0.2 lb ai/a per season. Group 23 insecticide.
- ◆ thiamethoxam (Platinum) at 0.125 lb ai/a. PHI 65 days. REI 12 hr. Apply (1) to the soil as a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Do not exceed 0.125 lb ai/a per season. Group 4A insecticide.

Hop—Hop looper

Hypena humuli

Pest description and crop damage Caterpillars have two white lines along the back and a distinct whitish line on each side. The head is green and spotted with black dots. They seldom are a problem in Washington.

Management—chemical control

- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum interval between applications is 21 days. Group 3A insecticide.

- ◆ *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ cyfluthrin (various formulations) at 0.025 lb ai/a. PHI 7 days. REI 12 hr. Do not apply more than five times per crop season. Do not apply more than 0.125 lb ai/a per season of any formulation of cyfluthrin. Allow at least 14 days between applications. Group 3A insecticide.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/a. PHI 28 days. REI 4 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ imidacloprid/beta-cyfluthrin (Leverage 360) by ground or air at 0.075 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.125 lb ai/a of any beta-cyfluthrin formulation, more than 0.250 lb ai/a of any beta-cyfluthrin/cyfluthrin formulation or more than 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/a. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/a per season. Group 5 insecticide.
- ◆ spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/a. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/a per season. Some formulations are OMRI-listed for organic use. Group 5 insecticide.

Hop—Obliquebanded leafroller

Choristoneura rosaceana

Pest description and crop damage Small caterpillars are tan. Mature caterpillars are green with black heads. In some seasons, caterpillars web in hop cones and cause some damage. They are not usually a serious pest.

Management—chemical control

- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum application interval is 21 days. Group 3A insecticide.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a

of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.

- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- ◆ spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/a. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/a per season. Group 5 insecticide.

Hop—Omnivorous leaf-tier

Cnephasia longana

Pest description and crop damage Caterpillars are up to 0.6 inch long and light cream to gray, with a light stripe on each side of the back. The head is brown. They feed on terminal hop buds causing lateral growth, which may necessitate extra training.

Management—chemical control

- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3 insecticide.

Hop—Prionus beetle

Prionus californicus

Pest description and crop damage Adult beetles are brown, 1.5 to 3.5 inches long and 0.75 inch wide. Antennae are long and sweeping and may be saw-like. Larvae are legless white grubs 0.25 to 3 inches long. The head is brown with strong protruding jaws. Adults emerge in July and lay eggs near the base of the hop plant. Adults live about 4 weeks, and do not feed. Larvae live in the soil for 3 to 5 years, feeding on hop roots. Larvae feeding results in decreased nutrient uptake, water stress, and reduced plant growth, and heavy infestations will cause wilting, yellowing, and the death of one or more vines, or the entire plant. Adult males are strongly attracted to a female-produced mating pheromone that is commercially available for monitoring presence of adult beetles.

Management—chemical control

- ◆ ethoprop (Mocap EC) at 3 lb ai/a on baby hops (nonproducing) or producing hops. REI 72 hr. Group 1B insecticide.
 - *Baby hops, post-plant, pre-emergence:* apply as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row.
 - *Baby hops, pre-plant:* apply as a broadcast application and immediately incorporate into the top 2 to 4 inches of soil using a disc or rotary cultivator.

- *Producing hops:* apply in the spring after pruning, but before stringing, or post-harvest as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row. PHI 90 days. Make only one application per year. Do not apply more than 3.0 lb ai/a per year. Do not apply to saturated soil which increases runoff or to dry soils which decreases effectiveness.

Hop—Root weevil

Includes

Black vine weevil (*Otiorhynchus sulcatus*)
Rough strawberry root weevil (*Otiorhynchus rugosostriatus*)
Strawberry root weevil (*Otiorhynchus ovatus*)

Pest description and crop damage Larvae are legless white grubs with tan heads. They overwinter 2 to 30 inches deep in the soil. Adults generally are black but may be brown. The smallest weevil, *O. ovatus*, is the most injurious. Larvae feed on plant roots. Adults feed on foliage but cause no significant damage.

Management—chemical control

- ◆ azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum application interval is 21 days. For best results, apply as a foliar spray at night to the plant base and lower 3 feet of vine. Group 3A insecticide.
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/a. REI 12 hr. PHI 28 days. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3 insecticide.
- ◆ thiamethoxam (Platinum) at 0.125 lb ai/a. PHI 60 days. REI 12 hr. Do not exceed 0.266 lb ai/a per season. Apply (1) to the soil a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Group 4A insecticide.

Hop—Spider mite

Twospotted spider mite (*Tetranychus urticae*)

Pest description and crop damage Adults are small, eight-legged, spider-like animals. They are pale green to yellowish to reddish, often with a dark spot on each side of the body. They suck plant juices from leaves and hop cones.

Management—chemical control

- ◆ abamectin (various formulations) at 0.009 to 0.019 lb ai/a. PHI 28 days. REI 12 hr. No more than two applications per season; do not apply second application within 21 days of first. Another compound must be used between abamectin applications. Do not apply more than 0.038 lb ai/a per season. Do not apply in less than 40 gal/a of water. Do not apply by air. Group 6 insecticide.

- ◆ acequinocyl (Kanemite 15 SC) at 0.3 lb ai/a. PHI 7 days. REI 21 hr. Do not apply by air or in less than 100 gals of water per acre. Allow at least 21 days between treatments. Do not make more than two treatments per season. Do not apply more than 0.6 lb ai/a per season. Do not use adjuvants or surfactants. Group 20B insecticide.
- ◆ bifenazate (Acramite 50WS) at 0.38 to 0.75 lb ai/a. PHI 14 days. REI 12 hr. Do not apply in less than 50 gal/a. Do not make more than one application per season. Do not apply by air. REI 12 hr. Group 20D insecticide.
- ◆ bifenthrin (various formulations) at 0.06 to 0.1 lb ai/a. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/a per application or 0.3 lb ai/a per season. Minimum application interval is 21 days. For late-season control by air, apply at least 0.1 lb ai/a in at least 10 gal water/a. Group 3A insecticide.
- ◆ *Chromobacterium subsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- ◆ crop/horticultural/stylet oils (various formulations) at 1 to 2 gal per 100 gal water. PHI 0 days. Follow label directions. Local SLN registrations may apply; verify label is in effect before use. Apply as needed. Thorough coverage is essential. Do not apply propargite (Omite) along with, or for 30 days following, an oil spray, or when temperatures exceed 90°F. Some formulations are OMRI-listed for organic use.
- ◆ etoxazole (Zeal) at 0.135 to 0.180 lb ai/a. PHI 7 days. REI 12 hr. Do not make more than one application per season. Do not apply more than 4 oz per season. Group 10B insecticide.
- ◆ fenazaquin (Magister SC) at 0.3 to 0.45 lb ai/a. PHI 7 days. REI 12 hr. Apply only once per year. Do not apply more than 0.45 lb ai/a per application. Do not apply by air or through any type of irrigation system. Group 21 insecticide.
- ◆ fenpyroximate (Fujimite 5EC) at 0.1 to 0.15 lb ai/a. PHI 15 days. REI 12 hr. Apply before mite populations exceed 5 per leaf. Use in sufficient volume to ensure adequate coverage. Spray concentrations above 100 ppm are recommended; see label. Do not make more than one application per season. Do not exceed 0.15 lb ai/a per season. Do not apply by air or through any type of irrigation system. Rotate at least two other miticides between fenpyroximate applications. Group 21A insecticide.
- ◆ hexythiazox (Savey 50DF) at 0.125 to 0.187 lb ai/a. PHI Apply up to burr formation. REI 12 hr. Apply only once per season. Savey controls mites through activity on eggs and immature stages. Although it doesn't directly control mite adults, it renders eggs laid by treated female adults nonviable. Complete coverage of leaf surface is essential for effective control. Group 10A insecticide
- ◆ imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/a. PHI 28 days. PHI 12 hr. Do not apply more than 0.1 lb ai/a of imidacloprid or more than 0.1 lb ai/a of bifenthrin per application. Do not apply more than 0.30 lb ai/a of any bifenthrin formulation or 0.30 lb ai/a of any imidacloprid formulation per season. Group 4A/3A insecticides.
- ◆ malathion (various formulations) at 0.5 to 1.25 lb ai/a. See label for rates. PHI 7 or 10 days; check label. REI 12 hr. Group 1B insecticide.
- ◆ naled (Dibrom 8E) at 0.94 lb ai/a. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. A legal pesticide use not found on the pesticide label and not recommended by University of Idaho personnel. Group 1B insecticide.
- ◆ potassium salts of fatty acids (M-pede)—Check label for rates. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- ◆ propargite (Comite, Comite II, Omite 6E) at 1.5 to 2.5 lb ai/a. See label for rates. PHI 14 days. REI 7 days. Before applying, check current label for re-entry rules, tank-mix limitations, and other

restrictions. Do not apply propargite during, with, or following an oil spray. Do not apply more than twice a season. Do not use propargite with nutrient sprays or when daytime temperatures are expected to exceed 95°F. Do not apply in combination with petroleum-based foliar sprays. Application with alkaline materials such as lime sulfur or Bordeaux mixture reduces effectiveness. Group 12C insecticide.

- ◆ spirodiclofen (Envidor 2SC) at 0.188 to 0.33 lb ai/a. PHI 7 days. REI 12 hr. No more than one application per season. No more than 0.33 lb ai/a per season. Minimum application volume 100 gpa by conventional air blast sprayers or 30 gpa using high velocity, low volume sprayers. Group 23 insecticide.
- ◆ sulfur (various formulations) at 3 to 45 lb ai/a; see label for rates. REI 24 hr. Do not apply in combination with or within 2 weeks of an oil - or petroleum-based foliar spray, such as emulsifiable concentrates. Sulfur may burn foliage, flowers, or cones if applied when temperatures are high. Use when temperature is above 85° F is not recommended.

Hop—Western spotted cucumber beetle

Diabrotica undecimpunctata

Pest description and crop damage Yellowish green, black-spotted beetles. They feed on foliage and growing tips and occasionally feed on hop cones. A pest in western Oregon and western Washington.

Management—chemical control

- ◆ pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/a azadirachtin/0.014 to 0.048 lb ai/a pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.

Mint Pests

Will Jessie

Latest revision—March 2020

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.

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

We have tried to include OMRI-listed products for pests when available. Be aware also that there are other products not mentioned here that are available. Many of these are based on mineral or horticultural oils, as well as oils from sesame, garlic, clove, thyme, rosemary and other herbs/spices that list various pests controlled when used on mint. Some of these products are acceptable for use in the production of “organically grown” mint.

Mint—Alfalfa looper and cabbage looper

Includes

Alfalfa looper (*Autographa californica*)

Cabbage looper (*Trichoplusia ni*)

Pest description and crop damage Larvae of both species are pale green with white lines on backs and sides. Larvae have three pairs of abdominal prolegs, whereas cutworms and armyworms have five pair. Larvae of loopers move in a “looping” manner similar to inchworms. Moths are gray-brown with a silvery oval and a U-shaped spot on forewings.

In the Willamette Valley of Oregon, damage during the early season (May and early June) may appear serious. However, the plant almost always repairs the damage by harvest. This generation is usually heavily parasitized, greatly reducing potential for late-season damage from this pest.

Scouting and thresholds Inspect fields in June and early July when scouting for the more serious pests such as mint root borer, variegated cutworm, and Bertha armyworm. Count loopers the same as these pests when doing ground searches for larvae and tallying numbers for each sq ft sample. Treatment levels, which vary with vigor and age of field and the price of mint oil, usually are from one to four larvae (total of all worm species per sq ft).

Management—biological control

Naturally occurring insect viruses are often very effective at keeping looper levels below the economic threshold. Off-color, flaccid and slow moving larvae are indicative of viral infection. Parasitic wasps and flies usually minimize summer generation damage by killing larvae in May and June. Look for small black blotches on otherwise pale green and white larvae of loopers, as these usually indicate parasitization. This insect can be controlled with *Bacillus thuringiensis* formulations when larvae are small and leaf coverage is complete.

Management—cultural control

Larval feeding damage in May and June, particularly in western Oregon, is usually confined to those leaves that appear in the spring

on the first regrowth nodes. The great majority of these leaves will become shaded out, senesce, and fall well before harvest. Thus, treating fields with an insecticide specifically for loopers at this stage is generally uneconomical and may reduce potential for biological control by killing beneficial insects.

Management—chemical control

- ◆ acephate (Acephate 90WDG) at 1 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 spent mint hay to animals. Limit 2 treatments per season.
- ◆ *Bacillus thuringiensis* at 0.12 to 1.5 lb/a. PHI 0 days. REI 4 hr. Treat mint when larvae are small. OMRI-listed for organic use.
- ◆ *Burkholderia* spp. (Venerate XC) at 1 to 8 qt/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.2 lb ai/a or 4 applications per season. Retreatment interval 14 days. May be applied by chemigation.
- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/a. Do not use adjuvants. Retreatment interval 14 days. PHI 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. Apply in at least 10 gal water/a. OMRI-listed for organic use.
- ◆ GS-omega/kappa/*Bacillus thuringiensis* (Spear-C Biological Insecticide) 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 7 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season. Apply in at least 20 gal water/a. May be applied by chemigation.
- ◆ methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. Time applications to small larvae and egg masses. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per application, nor more than 1.0 lb ai/a per year.
- ◆ methomyl (Lannate SP) at 0.9 lb ai/a. PHI 14 days. REI 48 hr. Apply in at least 10 gal water/a. Do not apply more than 1.8 lb ai/a per growing season or 4 applications.
- ◆ spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/a. PHI 7 days. REI 4 hr. Do not make more than 4 applications per year. Retreatment interval 4 days. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (spinosad). Do not exceed 0.305 lb ai/a per season.
- ◆ spinosad (Success, Entrust SC) at 0.063 to 0.156 lb ai/a. PHI 7 days. REI 4 hr. Do not exceed 0.45 lb ai/a per crop year. Retreatment interval 4 days. Target eggs and small larvae. Do not apply more than three times per crop year. 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 to 0.25 lb ai/a mid to late season. PHI 14 days. REI 4 hr. Retreatment interval 10 days. Apply in at least 8 gal water/a to small plants and 10 gal water/a to dense stands. Do not exceed 1 lb ai/a per season. Addition of a spreader-binder is recommended.

Warning: Do not use Lannate or Orthene if bees are foraging on mint or weeds during bloom. Use Confirm only in late evening if bees are present. May be applied during bloom.

Mint—Aphid

Includes mint aphid (*Ovatus crataegarius*)

Pest description and crop damage Wingless forms are apple green to yellow-green sometimes with mottled, darker markings. Winged forms have a dark brown head and thorax. Large populations stunt and distort stems and leaves, make plants more susceptible to water stress, and secrete honeydew, which can help to sunburn leaves or cover them with black, sooty mold.

Management—chemical control

- ◆ acephate (Acephate 90WDG) at 1 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 mint hay to animals.
- ◆ *Beauveria bassiana* (Mycotrol ESO) at 0.5 to 1 quart/100 gal when pests first appear. REI 4 hr. Most effective when used at first detection. OMRI-listed for organic use.
- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.05 to 0.1 lb ai/a. Do not use an adjuvant. Retreatment interval is 14 days. PHI 7 days. REI 12 hr. Do not exceed 15 oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 14 day. Best control is achieved when applied before large populations develop. Limit 3 treatments per season. Do not exceed 0.267 lb ai/a per season.
- ◆ malathion (Gowan Malathion 8) at 0.94 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 applications per year. Retreatment interval 7 days.
- ◆ neem oil or azadirachtin (Neemix 4.5 IGR, Certis and others) at 0.015 to 0.021 lb ai/acre. Some formulations are OMRI-listed for organic use.
- ◆ oxydemeton-methyl (MSR Spray Concentrate) at 0.1875 lb ai/a. PHI 14 days. REI 19 days. Retreatment interval 10 days. Two applications allowed per year. Apply in at least 20 gal water/a. Label allows chemigation.
- ◆ pyrethrins—Some formulations are OMRI-listed for organic use.
- ◆ thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Do not apply more than 0.188 lb ai/a per season. Retreatment interval 14 days.

Note: Actara, Malathion and Orthene are toxic to bees. Do not apply if mint or weeds in field are in bloom.

Mint—Armyworm and cutworm

Bertha armyworm (*Mamestra configurata*)

Mint cutworm (*Heliothis phloxiphaga*)

Spotted cutworm (*Xestia c-nigrum*)

Variegated cutworm (*Peridroma saucia*)

See also:

Mint—Redbacked cutworm

Pest description and crop damage Variegated cutworm larvae are brown to tan usually with a series of white or yellowish “keyhole” marks on each dorsal (top) abdominal segment, though may not always be visible on all segments. Bertha armyworm larvae are highly variable, from uniform pale green to black with fine longitudinal yellow lines.

Mint cutworm are large, yellow, tan, or green larvae with black spots over the body, similar to corn earworm. Damage is similar to that of the variegated cutworm and alfalfa looper, but this insect seldom is a problem of economic importance on mint. Spotted cutworm larvae vary in color, but most are dark brown to black, with distinct, triangular markings on the back.

Scouting and thresholds Scout for larvae beginning in late June to determine the need for insecticide application to prevent oil yield

loss. Inspect surface of the soil under the mint canopy after shaking stems to dislodge larvae. Do this in a number of sites throughout the field. Carefully look for larvae in soil cracks, under leaves, and in old, brown, curled leaves. Record the number of larvae per sq ft. Treatment levels can vary from one to four larvae per sq ft depending on time to harvest, biological controls observed, and price of oil.

Management—biological control

Bacillus thuringiensis formulations have not been effective on these pests infesting peppermint. Neither do insect viruses, important natural controls of loopers, help in reducing these pests

Management—chemical control

Warning: Do not apply if bees are working in blooming mint.

- ◆ acephate (Acephate 90WDG) at 1 lb ai/a. PHI 14 days. REI 24 hr. Limit 2 treatments. Retreatment interval 7 days. Do not exceed 2 lb ai/a per season. Do not feed spent mint hay to animals.
- ◆ *Burkholderia* spp. (Venerate XC) at 1 to 8 qt/a. PHI 0 days. REI 4 hr. Armyworms only. OMRI-listed for organic use.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.2 lb ai/a or 4 applications per season. Retreatment interval 14 days. May be applied by chemigation.
- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/a. Do not use adjuvants. Retreatment interval 14 days. PHI 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a. Cutworms only.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.94 to 1.88 lb ai/a. PHI 90 days. REI 24 hr. Use the lower rate when larvae are less than 0.75 inch long; use the higher rate if larvae are longer than 0.75 inch. May be applied through a specified sprinkler irrigation system or with ground spray equipment in at least 10 gal water/a. Only one application is permitted during growing season and one post-harvest.
- ◆ *Chromobacterium subsugae* (Grandevo) at 0.3 to 0.9 lb ai/a per 100 gal. PHI 0 days. REI 4 hr. Armyworms only. Apply in at least 10 gal water/a. OMRI-listed for organic use.
- ◆ GS-omega/kappa/*Bacillus thuringiensis* (Spear-C Biological Insecticide) 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 7 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/a per season. Apply in at least 20 gal water/a. May be applied by chemigation.
- ◆ methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. Time applications to small larvae and egg masses. Retreatment interval 7 days. Do not exceed 0.25 lb ai/a per application, nor more than 1.0 lb ai/a per year.
- ◆ methomyl (Lannate SP) at 0.9 lb ai/a. PHI 14 days. REI 48 hr. Most effective on larvae smaller than 0.5 inch. Do not exceed 1.8 lb ai/a nor 4 applications per season.
- ◆ spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/a. PHI 7 days. REI 4 hr. Do not apply more than 0.305 lb ai/a per crop. Do not make more than 4 applications per year. Retreatment interval 4 days. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (e.g. Spinosad).
- ◆ spinosad (Success, Entrust SC) at 0.063 to 0.156 lb ai/a. PHI 7 days. REI 4 hr. Do not exceed 0.45 lb ai/a per crop year. Retreatment interval 4 days. Target eggs and small larvae. Do not apply more than three times per crop year. 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 to 0.25 lb ai/a mid to late season. PHI 14 days. REI 4 hr. Apply in at least 8 gal water/a to small plants and 10 gal water/a to dense stands. Do not exceed 1 lb ai/a per season. Addition of a spreader-binder is recommended.

Mint— European Cranefly

Tipula paludosa

Pest description and crop damage Larvae are called leatherjackets because of the leathery appearance of the cuticle. They feed on roots and underground rhizomes from fall through spring months. In western Oregon, *T. paludosa* larvae feed on and topple upright stems in April and May. In the Columbia Basin, large populations of the larvae of *Nephrotoma ferruginea*, have been noticed in late October and November feeding on small roots.

Note: It is questionable whether spring damage to stems by *T. paludosa* justifies insecticide application.

Biology and life history Adult *T. paludosa* emerge from overwintering third-instar larvae from late July through October. Upon emergence, adults do not feed but instead quickly mate and begin laying eggs for 2-14 days. Often described as a large mosquito, cranefly adults are approx. 1 inch in length with long wings and legs. Oviposition sites are typical moist soil areas to protect eggs from dessication prior to hatching in about 14 days. Larvae can be found in the soil profile from October through June. Following the overwintering period in the third instar, larvae molt to the fourth instar in April and feed before pupation in July and August. This species has one generation per year.

Scouting and thresholds Look for the large adults of *T. paludosa* flying in fields in August and September. Take soil samples and screen soil to a depth of 2 to 4 inches from mid to late October through June in order to determine larval populations. In spring, look for clipped uprights and locate larvae in soil nearby. Larval numbers in excess of 10 per sq ft may injure mint. Insecticidal control is most economical when applied in the fall, when larvae are small and before significant damage occurs.

Management—chemical control

- ◆ chlorpyrifos (Lorsban Advanced) at 0.47 to 0.94 lb ai/a. PHI 90 days. REI 24 hr. Apply in fall or spring through irrigation or ground application in the rain (for optimal effectiveness). Lorsban may be applied only once postharvest and once during the growing season. Lorsban is not labeled for cranefly control in mint but is registered to control other pests on the crop. Research and field use in Oregon indicate it is effective against European cranefly (*T. paludosa*).

Mint—Garden symphylan

Scutigera immaculata

Pest description and crop damage Small (less than 0.25 inch), white, centipede-like animals that feed on hairs and meristematic tissue of roots and underground stems. Heavy feeding causes plant stunting, poor stem elongation, and small, chlorotic leaves. This arthropod is a severe pest of many crops in western Oregon.

Biology and life history Populations build rapidly in spring and summer, and usually migrate downward from late summer through fall as soil temperatures rise and moisture content drops. Populations migrate up toward soil surface in the fall as soil moisture increases with the onset of rain. They may damage roots during mild winters.

Scouting and thresholds Take soil samples roughly a standard shovel width (roughly 1 cubic ft) to a depth of 8 to 12 inches. Symphylans usually are sampled in April, May, and June shortly after irrigation or rain when soil is moist. Soil should be nearly at carrying capacity, but sufficiently dry so it fractures or crumbles easily, exposing symphylans in natural tunnels, crevices, worm holes, etc. Damage to mint likely occurs at densities of five to ten per cubic ft of soil.

Management—chemical control

Pre-plant

- ◆ chlorpyrifos (Lorsban Advanced) at 1.88 lb ai/a. PHI 90 days. Broadcast and incorporate at planting. Do not use in conjunction with a foliar application of chlorpyrifos.
- ◆ 1,3-dichloropropene (Telone II) at 18 to 35 gal/a only as a broadcast treatment. See labels for use rate and application methods.
- ◆ ethoprop (Mocap EC or 15G) at 3 lb ai/a (6 lb ai/a if nematodes also a problem). PHI 225 days. REI 48 to 72 hr. Prior to planting evenly broadcast 15G or EC over soil surface and immediately incorporate to a depth of 2 to 4 inches using rotary tiller or hoe, harrow, double disk or with 1 to 2 inches of irrigation water followed by another 1 to 2 inches when the soil becomes moist but not dry. Make only one application whether pre-plant or post-harvest per growing season.
- ◆ metam sodium—See Vapam label for use rate, timing and application methods.

Post-harvest

- ◆ ethoprop (Mocap EC or 15G) at 3 lb ai/a (6 lb ai/a if nematodes also a problem). PHI 225 days. REI 48 to 72 hr. Use as pre-plant or after last harvest. evenly broadcast 15G or EC over soil surface and immediately incorporate to a depth of 2 to 4 inches using rotary tiller or hoe, harrow, double disk or with 1 to 2 inches of irrigation water followed by another 1 to 2 inches when the soil becomes moist but not dry. Make only one application whether pre-plant or post-harvest per growing season.

See also:

Biology and Control of the Garden Symphylan

Mint—Grasshopper

Includes

Clearwinged grasshopper (*Camnula pellucida*)

Pest description and crop damage Both young and adults feed on leaves. Leaf loss can be significant in years with warm, dry spring-time conditions.

Biology and Life History Grasshoppers damage mint grown on both sides of the Cascade mountains. Grasshoppers have one generation per year. In late summer adult grasshoppers deposit pods into the soil from one to two inches deep. These pods contain several eggs each. Eggs hatch in the spring (around May). Small hoppers disperse to crops and feed through the spring and summer.

Management—chemical control

- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/a. Do not use adjuvants. Retreatment interval 14 days. PHI 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ malathion (Gowan Malathion 8) at 1 lb ai/a. PHI 7 days. REI 12 hr. Malathion is registered for use on mint to control other pests. Field use indicates it controls grasshoppers effectively. **Note:** Summer cutworm sprays help control grasshoppers.
- ◆ thiamethoxam (Actara) at 0.047 to 0.063 lb ai/a. PHI 7 days. REI 12 hr. Do not apply more than 0.188 lb ai/a per season. Retreatment interval 14 days.

Mint—Mint flea beetle

Longitarsus waterhousei

Pest description and crop damage Small, pale brown to brownish-yellow flea beetles feed on mint foliage producing “shot-holed leaves.” These usually are noticed first in late June, July. The main damage is by the larvae, which feed on and severely damage roots in late April, May, and June.

Biology and life history Eggs overwinter in the soil and hatch from early April through May. Larvae feed on roots and tunnel rhizomes through early June. Adults emerge in late June and July and feed, mate, and deposit eggs in or on the soil in July and August. There is a two to three week pre-ovipositional phase before females lay eggs. Insecticides applied to control adults should be used at this time to prevent larval infestations. There is one generation per year.

Scouting and thresholds Larvae can be seen tunneling in roots and underground stems in late April, May, and June. Screen and inspect roots and associated soil for larvae and damage. Inspect leaves for adult “shot-holing” from late June through early August. Use a sweep net to collect adults in early morning hours when beetles easily are swept from foliage (below 60°F).

Infestations usually begin at field margins. Inspect the entire field for larval and adult damage. Generally, adult populations are spotty and localized. Because of the potential for damage, they usually are treated when detected (early July).

For adult control, the idea is to apply an insecticide after most adults have emerged but before females have commenced egg laying.

Management—cultural control

This insect is moved from field to field primarily in infested rootstock, usually as eggs in the soil. Plant rootstock from fields free of this pest.

Management—biological control

- ◆ parasitic nematodes (BioNem-C, Becker Underwood) at 3 billion per acre. Apply between April and June after larvae hatch from overwintering eggs and are active. Be sure that soil temperature is warm enough for nematodes to be active. Application with irrigation water is essential for nematodes to be effective. Unfortunately, this precludes effective timing in most of central Oregon. OMRI-listed for organic use

Management—chemical control

These are directed at the adult stage.

- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.05 to 0.11 lb ai/a. Do not use an adjuvant. Retreatment interval 14 days. PHI 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ malathion (Gowan Malathion 8) at 0.94 lb ai/a. PHI 7 days. REI 12 hr. Apply malathion as a full coverage spray after adults emerge, usually in early July. Time sprays for early morning hours when beetles are on foliage and easiest to kill. Limit 3 applications per year. Retreatment interval 7 days.
Warning: Malathion is toxic to bees. Use malathion only during late evenings if mint or weed bloom is present and bees are foraging.
- ◆ methomyl (Lannate SP) at 0.68 to 0.9 lb ai/a. PHI 14 days. REI 48 hr. Apply Lannate as a full coverage spray after adults emerge, usually in early July. Do not apply more than 1.8 lb ai/a per crop season. Warning: Lannate is toxic to bees.
- ◆ thiamethoxam (Actara) at 0.023 to 0.047 lb ai/a. PHI 7 days. REI 12 hr. Do not apply more than 0.188 lb ai/a per season. Retreatment interval 14 days.

Mint—Mint root borer

Fumibotys fumalis

Pest description and crop damage Early instar larvae are light green/yellow with dark stripes down the back; older larvae can be up to 0.75 inch long and are yellow/tan with a brown head. They feed inside mint rhizomes and on mint roots, from late July through September and early October in some years. This pest can severely reduce stands in most mint-producing areas.

Biology and life history This pest overwinters in the soil around mint roots as a pre-pupa in a cocoon, pupates in the spring, and emerges as a moth May through July. There is one generation per year.

Scouting and thresholds Sample mint after harvest in late August through mid-September, when most larvae are large enough to detect, but have not caused much damage.

Screen square-foot soil samples taken at the depth of the rhizomes. Record larval numbers, and treat when larvae number from two to four per sq ft depending on age and vigor of the field, other pests or stresses, and oil price.

Adult moths can be sampled using sweep nets and/or pheromone-baited sticky traps. Although economic thresholds for adult moth numbers do not exist, sampling can be used in combination with known issues in previous years to plan for in-season control of mint root borer eggs and caterpillars before damage occurs.

Management—chemical control

- ◆ chlorantraniliprole (Coragen, Coragen 2ee) at 0.045 to 0.098 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.2 lb ai/a or 4 applications per season. Retreatment interval 14 days. May be applied by chemigation.
- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/a. Do not use an adjuvant. Retreatment interval 14 days. PHI 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ chlorpyrifos (Lorsban Advanced) at 1.9 lb ai/a (postharvest). PHI 90 days. REI 24 hr. Most effective when applied as chemigation treatment in late August through early September. Pre-irrigation of dry soils is essential to control. If you apply Lorsban as a broadcast spray, immediately follow with overhead irrigation (1 acre inch). Dry soil, strawload, organic matter, and charcoal residue greatly reduce Lorsban’s effectiveness. One postharvest application allowed per season.
- ◆ ethoprop (Mocap EC or 15G) at 3 lb ai/a (6 lb ai/a if nematodes also a problem). PHI 225 days. REI 48 to 72 hr. After last harvest, evenly broadcast 15G or EC over soil surface and immediately incorporate to a depth of 2 to 4 inches using rotary tiller or hoe, harrow, double disk or with 1 to 2 inches of irrigation water followed by another 1 to 2 inches when the soil becomes moist but not dry. Make only one application whether pre-plant or post-harvest per growing season.
- ◆ parasitic nematodes (BioNem-C, Becker Underwood) at 1 to 1.5 billion per acre. Apply in late August or early September when larvae are small. Application with irrigation water is essential for nematodes to be effective. OMRI-listed for organic use

Mint—Mint stem borer

Pseudobaris nigrina

Pest description and crop damage A small white grub, 0.08 to 0.16 inch long, with a brown head and no legs. Damage is to the main root, causing injury or death to the central stalk, which usually breaks off. It is found in eastern Oregon and Idaho. . It can infest mint rootstock for export.

Management—chemical control

No insecticides are registered. However, aphid or looper sprays applied in mid- to late May generally reduce mint stem borer populations.

Mint—Painted lady or thistle butterfly

Vanessa cardui

Pest description and crop damage Spiny, dark caterpillars with pale yellow stripes on sides. Larvae feed communally, associated with webbing and black frass.

Biology and life history Butterflies migrate into Oregon from California during springs following mild winters and lay eggs on thistle weeds in mint and other crops beginning in late spring. Larvae may migrate to and readily feed on leaves of mint and other crops or weeds in years of abundance. This insect is beneficial when feeding on thistle.

Scouting and thresholds Note that treatable field populations are rare. However economic injury may occur if larvae defoliate mint leaves from July through harvest and reach numbers given for cutworms and armyworms above.

Management—chemical control

Insecticides timed for looper or early season cutworm control will provide adequate control.

Mint—Redbacked cutworm

Euxoa ochrogaster

Pest description and crop damage Redbacked cutworm (RBC) is a key pest of mint east of the Cascades. As mint begins to send up aerial growth in the spring, larvae feed underground by day, clipping off new spring shoots at or below ground level. At night, larvae feed on and above the soil surface. In some years, damage to mint during May and early June in central Oregon has been severe enough to result in extensive stand loss in absence of larval control. It is more a problem in sandier, non-compacted soils.

Biology and life history Beginning in mid-April, larvae hatch from eggs laid by moths the previous summer. Larvae feed through June, pupate, and emerge as moths in late June and early July. Moths are active during the summer and deposit the overwintering eggs on the soil beneath plants or debris through early fall. There is one generation a year.

Scouting and thresholds About mid-May, walk fields, looking closely at new growth above ground. Wilted, clipped-off shoots indicate RBC feeding. Confirm by taking soil samples to a depth of about 2 inches, screen the soil, and record numbers of larvae observed per sq ft. An average of from two to six larvae per sq ft sample can result in economic damage and oil loss (most severe in new mint and old, poor-vigor stands).

Management—cultural control

Heavier soils often escape injury from this pest. Fall plowing destroys eggs and almost always reduces larval infestations to noneconomic levels.

Management—chemical control

- ◆ acephate (Acephate 90WDG) at 1 lb ai/a. PHI 14 days. REI 24 hr. Late evening or night applications are most effective. Apply through a specified sprinkler irrigation system or with ground spray equipment in at least 10 gal/a water. Do not apply more than twice per season. OR-090026.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/a. PHI 3 days. REI 4 hr. Do not exceed 0.2 lb ai/a or 4 applications per season.

Retreatment interval 14 days. May be applied by chemigation.

- ◆ chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/a. Do not use an adjuvant. Retreatment interval 14 days. PHI is 7 days. REI 12 hr. Do not exceed 15oz/a Voliam Flexi or 0.188 lb ai/a (thiamethoxam) or 0.2 lb ai/a (chlorantraniliprole) per season. Apply in at least 10 gal water/a.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.94 to 1.9 lb ai/a. REI 24 hr. Use the lower rate when larvae are less than 0.75 inch long; use the higher rate if larvae are longer than 0.75 inch. Late evening or night applications are most effective. Apply through a specified sprinkler irrigation system or with ground spray equipment in at least 10 gal water/a. One application only during growing season. Do not apply within 90 days of harvest.
- ◆ GS-omega/kappa/Bacillus thuringiensis (Spear-C Biological Insecticide) 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 0.16 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. Time applications to small larvae and egg masses. Do not apply more than 0.25 lb ai/a per application, nor more than 1.0 lb ai/a per year.

Mint—Root weevil

Black vine weevil (*Otiorhynchus sulcatus*)

Strawberry root weevil (*O. ovatus*)

Pest description and crop damage Larvae are legless white grubs with tan heads. They overwinter 2 to 8 inches deep in the soil. Adults generally are black but may be brown or chocolate brown. Larvae feed on mint roots, and adults feed on foliage.

Scouting and thresholds Sweep fields for adults on a calm, warm night (above 70°F) beginning in late May, June. A few weevils (five or more) in the net after 10 sweeps at various sites within the field may need control. An infestation of from five to eight larvae per 1 sq ft soil sample the depth of the mint roots usually signals need for control. Sample for larvae in April/May.

Management—biological control

- ◆ parasitic nematodes (BioNem-C, Becker Underwood) at 3 billion per acre. Apply post-harvest in SEP to pre-moistened soil in irrigation water. Application with irrigation water is essential for nematodes to be effective. OMRI-listed for organic use.

Management—chemical control

- ◆ acephate (Acephate 90WDG) at 1 lb ai/a. For control of adult weevils. PHI 14 days. Apply late May through early June after adults emerge but before egg laying. Apply when weevils are feeding actively on foliage. Apply on warm, still evenings, usually between 10 p.m and 2 a.m. Two applications 10 to 14 days apart may be necessary to reduce large infestations, particularly in central Oregon. Do not use Orthene more than twice per season.
- ◆ *Beauveria bassiana* (Mycotrol-O, Emerald Bioagriculture, Laverlam Int.)—OMRI-listed for organic use.

Mint—Slug

Includes

European black slug (*Arion ater*)

Gray garden slug (*Deroceras reticulatum*)

Great gray garden slug (*Limax maximus*)

Marsh slug (*Deroceras laeve*)

See also:

Slug Control

The use of metaldehyde formulations and baits and iron phosphate baits are discussed. Economic injury levels and thresholds for controlling slugs infesting mint have not been determined.

Management—chemical control

- ◆ iron phosphate/spinosad (Bug-N-Sluggo) at 0.2 to 0.44 lb ai/a. PHI 7 days. REI 4 hr. Do not exceed 3 applications. Retreatment interval 4 days. OMRI-listed for organic use.
- ◆ metaldehyde products including liquids, sand coated granules and baits as labeled for mint until depleted.

Mint—Spider mite

Includes spider mite (*Tetranychus urticae*)

Pest description and crop damage Spider mite adults are small, eight-legged, spiderlike animals associated with webbing and round eggs on the underside of leaves. They are pale green, yellowish to reddish, with two large, dark spots on each side of their bodies. They suck plant juices, causing leaves to yellow, dry, and fall under heavy infestations. They reduce oil yield and probably quality.

Biology and life history Mites overwinter as mature females found at the bases of mint stems and underground. In spring, feeding begins on new growth soon after emergence from soil. Populations are delayed a few weeks in fields flamed for rust in the spring. Females lay eggs associated with silk webbing. Egg to adult may take as little as 14 days during the hot part of summer. There are multiple generations each year.

Scouting and thresholds Average numbers of mites per leaf are determined throughout a field on a weekly basis. Take 45 leaf samples (three leaves per stem, 15 stems per site), and use the presence or absence of mites on leaves to estimate a mean number of mites per leaf at a site in a field. Stable and increasing populations of spider mites beginning at levels of five mites per leaf can reduce oil yields if not controlled.

Management—cultural control

Fall plowing and fall and spring flaming tend to delay spider mite buildup early in the season. These practices can also reduce predator populations whose absence sometimes allows for a more rapid spider mite population build-up in the spring than would otherwise occur.

Management—biological control

Predator mites naturally occurring in the field as well as those bought from suppliers and released into fields early in the season before spider mites reach damaging levels can maintain spider mite levels sufficiently low to avoid miticide applications. This assumes that production practices that reduce predator mites can be avoided or timed so as to reduce their negative effects.

Management—chemical control

- ◆ abamectin (ABBA, Agri-Mek 0.15EC) at 0.009 to 0.014 lb ai/a. PHI 28 days. REI 12 hr. Do not apply more than twice consecutively or within 7 days of the first. Do not apply more than three times per crop season nor exceed 0.042 lb ai/a per season. An organosilicone surfactant increases efficacy.
- ◆ bifentazate (Acrامة 4SC) at 0.375 to 0.75 lb ai/a. PHI 7 days. REI 12 hr. One application per year only. May be applied through chemigation.
- ◆ dicofol (Dicofol 4E) at 0.875 to 1.25 lb ai/a. PHI 30 days. REI 32 days. Do not feed treated hay or spent hay to livestock. Very toxic to predator mites. One application per season. Washington only.
- ◆ etoxazole (Zeal) at 0.09 to 0.18 lb ai/a. PHI 7 days. REI 12 hr. Do not exceed 0.18 lb ai/a per season. Limit 1 treatment per year.
- ◆ fenpyroximate (FujiMite 5EC) at 0.625 to 1.25 lb ai/a. PHI 1 day. REI 12 hr. Limit 2 applications per season. Do not exceed 2.5 lb/a per season. Retreatment interval 7 days.
- ◆ hexythiazox (Onager Optek) at 0.094 to 0.156 ai/a. PHI 30 days. REI 12 hr. One application per year. SLN OR-170009; ID-170003;

WA-170005.

- ◆ malathion (Gowan Malation 8) at 0.94 lb ai/a. PHI 7 days. REI 12 hr. Limit 3 applications per year. Retreatment interval 7 days.
- ◆ oxydemeton-methyl (MSR Spray Concentrate) at 0.1875 lb ai/a. PHI 14 days. REI 19 days. Retreatment interval 10 days. Apply in at least 20 gal water/a. Two applications allowed per year. Label allows chemigation.
- ◆ propargite (Omite 6E, Comite) at 1.5 to 2.0 lb ai/a. PHI 14 days. REI 7 days. Limit 2 applications per year. Retreatment interval 7 days. Ground and aerial applications are allowed. Do not exceed 4.1 lb ai/a per season. Do not feed treated mint to livestock.

Note: Use of carbamate and some OP insecticides may stimulate or increase spider mite populations by killing predator mites or even stimulating spider mite reproduction. Certain miticides, even though they initially control spider mites, may result in a subsequent rapid increase in numbers due to the effect on predator mites that contribute to biological control.

Note: Utility of Metasystox-R and malathion as miticides has diminished through the years with development of tolerance and/or resistance in some mite populations.

Mint—Thrips

Frankliniella spp.

Pest description and crop damage Small yellowish insects < 1 mm long. Feeding on undersides of leaves injures cells. Damage appears as stippling, silvery, and/or yellowing of leaves. Generally, thrips are a localized problem in drought-stressed areas of fields or portions of fields adjacent to a crop just harvested. Seldom a problem requiring insecticide.

Management—cultural control

Avoid water stress with proper irrigation regime.

Management—chemical control

- ◆ spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/a. Suppression only. PHI 7 days. REI 4 hr. Do not apply more than 0.305 lb ai/a per crop. Do not make more than 4 applications per calendar year. Do not make applications less than 4 days apart. Do not make more than 2 successive applications of this or other group 5 insecticides (spinosad).
- ◆ spinosad (Success, Entrust SC) at 0.063 to 0.156 lb ai/a. Suppression only. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/a per crop year. Do not apply more than three times per crop year. Do not make more than two successive applications of this or other group 5 insecticides (spinosad). Entrust SC is OMRI-listed for organic use.

Mint—Wireworm

Limonius spp.

Pest description and crop damage Brown, jointed, wiry, yellow to brown larvae of click beetles that feed on roots and underground stems of mint plants. Adults are brown elongate beetles from 0.33 to 0.75 inch long. Wireworms are a problem mainly when mint is planted into soil that is already infested. They do not become a problem in well managed and watered established mint.

Management—chemical control

- ◆ 1,3-dichloropropene (Telone II, C-17, or C-35) at 20 GPA. Evenly broadcast by soil injection to a depth of 14 inches. For preplant fumigation to be successful, soils need to be warm and moist.

Note: When ethoprop (MOCAP) is used pre-plant at rates to control garden symphylan or nematodes, wireworms are often suppressed.

Small Grain Pests

John Rinehold

Latest revision—March 2020

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.

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

Small grain—Aphid

Includes

Bird-cherry oat aphid (*Rhopalosiphum padi*)
Corn leaf aphid (*Rhopalosiphum maidis*)
English grain aphid (*Sitobion avenae*)
Greenbug (*Schizaphis graminum*)
Rose-grass aphid (*Metopolophium dirhodum*)

Pest description and crop damage Aphids are of various colors—green, yellow, reddish. They frequently show black on portions of the body such as legs, antennae, or base of cornicles (tube-like structures on the posterior abdomen). Some species are important as vectors of barley yellow dwarf virus (BYDV), which affects yield and quality of susceptible cereal cultivars. Attempts to reduce incidence of BYDV by controlling established populations of aphids have not been successful. Seed treatment insecticides of the neonicotinoid group have reduced BYDV incidence in southeast Washington. Imidacloprid (Gaucho 480) and thiamethoxam (Cruiser) applied as seed treatments at higher label rates can suppress vectoring of BYDV up to 150 days after crop emergence.

Sampling and thresholds To control aphids, apply insecticide when aphids average from two to ten per tiller, per stem, or per head, prior to dough stage. Insecticide applications after grain is in the milk stage of ripening are of no value.

Management—biological control

Occasionally aphids have been sufficiently abundant to cause localized damage to grain prior to grain fill, but usually they are held in check by predators and parasitoids.

Aphid predators and parasitoid wasps are important. Do not apply an insecticide until you have examined the field for the presence of predators or aphid mummies. Syrphid fly larvae and ladybird beetle larvae are common predators of value that reduce aphid populations. The wasp *Diaeretiella rapae* is a common and effective parasitoid of Russian wheat aphid in intermediate rainfall in southeast Washington.

Management—chemical control

Some success has been achieved with systemic granules drilled in at fall seeding time for winter wheat. This practice helps prevent in-field multiplication and spread of aphids that may vector BYDV. It does not prevent aphids from migrating into the wheat from other areas.

Some aphids such as bird cherry-oat aphid, English grain aphid and the Russian wheat aphid produce rolling on the leaves. Best control with insecticides is obtained before aphids begin to roll leaves.

Seed treatment

Seed treatments used on wheat and barley seed may provide some control of aphids:

- ◆ clothianidin (NipsIt Inside) at 0.75 to 1.79 fl oz/100 lb seed on-farm application.
- ◆ imidacloprid (Gaucho 600F) slurry seed treatment at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) /100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting.
- ◆ imidacloprid/metalaxyl/tebuconazole (GauchoXT). as seed treatment at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Groundwater advisory: metalaxyl is known to leach through soil into groundwater under certain conditions as a result of agricultural use. Do not graze or feed livestock on treated areas within 45 days after planting. Wheat, oats and barley only.
- ◆ thiamethoxam (Cruiser 5FS, Warden Cereals 360) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) /100 lb seed; (Crusier Vibrance Quattro) at 0.02 to 0.032 lb ai/100 lb seed. Cruiser Maxx for cereals has a groundwater advisory for Washington. Do not graze or feed livestock within 45 days of application.

Foliar treatment

Aphid control with foliar sprays is more successful when materials are applied during the warmer part of the day. Adequate coverage also is necessary: 5 gal water/a increases spray coverage and effectiveness.

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ azadirachtin (Aza-Direct, Ecozin 3EC) at 0.43 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. OMRI-listed for organic use.
- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pint/a. PHI 0 days. Do not apply more than 6 pints/a. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.23 to 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year. Wheat only.
- ◆ chlorpyrifos/gamma cyhalothrin (Cobalt) at 0.16 to 0.3 lb ai/a as foliar or chemigation application. REI 24 hr. PHI 14 days forage and hay, 30 days grain and straw. Do not exceed 1 lb ai/a chlorpyrifos per season. Limit 2 treatments per year. Wheat only.
- ◆ *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 (Tombstone) at 0.028 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ dimethoate (Dimethoate 400) at 0.25 to 0.375 lb ai/a, PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Wheat only.
- ◆ flupyradifurone (Sivanto 200SL) at 0.09 to 0.14 lb ai/a. PHI 7 days forage; 21 days grain, stover or straw. Retreatment interval 7 days. Do not exceed 0.365 lb ai/a per year.
- ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Maximum 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days. Do not exceed 0.06 lb ai/a per season.

- ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ malathion (Malathion 8) at 1 to 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 2 applications per season.
- ◆ methomyl (Lannate SP) at 0.225 to 0.45 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/a per season. Do not exceed 4 applications per season. Wheat only.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- ◆ sulfoxyflor (Transform WG) at 0.023 to 0.047 lb ai/a. REI 24 hr. PHI 14 days grain or straw, 7 days grazing, forage, fodder, hay harvest. Retreatment interval 14 days. Limit 2 treatment per crop. Do not exceed 0.09 lb ai/a per year. Barley, triticale and wheat only.
- ◆ thiamethoxam (Actara) at 0.0625 lb ai/a. PHI 21 days. REI 12 hr (barley only). Allow at least 7 days between applications. Do not exceed 0.125 lb ai/a per season. Barley only.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 14 days, also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat & triticale only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.12 to 0.28 lb ai/a. PHI for forage or hay 14 days; grain and straw 28 days. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Russian wheat aphid

Diuraphis noxia

Pest description and crop damage The Russian wheat aphid is relatively easy to identify. The aphid is light green, elongated, and spindle-shaped. Antennae are very short. It has a wart-like projection above the tail that gives it a two-tail appearance. Dorsal tubes (cornicles) are very short and not obvious.

Russian wheat aphid damage to grain is easy to recognize. The aphids secrete a toxin that causes leaf rolling and white (warm weather) or purple (cool weather) streaking on the leaves. Heavily infested plants are stunted severely and sometimes flattened. Heads of infested plants may become twisted and distorted and sometimes fail to emerge properly. Sometimes a large colony inside the flat leaf sheath can kill the head while leaving the rest of the tiller green.

Damage in the field appears first as patches of stunted or discolored plants which resemble drought-stressed areas. Whole fields can be lost if infestations are not detected and controlled early. Early detection is difficult because the pest tends to hide in the plant. Colonies are found most often in tightly rolled leaves near the base of the leaf, in leaf whorls, or concealed on the stem inside the flag leaf sheath. The easiest way to detect Russian wheat aphids is to look for the characteristic damage. Thoroughly inspect plants from several areas of the field for symptoms of aphid infestation.

Sampling and thresholds Economic thresholds for the Russian wheat aphid are:

- Fall—seedlings (1 tiller); 10% of plants infested.
- Fall—larger plants; treat if plants are stressed or there is danger of winter kill.
- Spring—winter grain green-up to appearance of first node; 5% of plants with reproducing populations and fresh damage.
- Spring—winter grain appearance of first node to head emergence; 10% of tillers infested.
- Spring—spring grain emergence to head emergence; 10% of tillers infested.
- Spring—head emergence to soft dough; treat only if heavy populations (i.e., more than 20 aphids per plant) develop on 10 to 20% of flagleaves or stems. After the soft dough stage, insecticide treatment will have little or no benefit.

Management—chemical control

Seed treatment

Seed treatments used on wheat and barley seed may provide some control of aphids.

- ◆ clothianidin (NipsIt Inside) at 0.75 to 1.79 fl oz/100 lb seed on-farm application.
- ◆ imidacloprid (Gaucho 600F) seed treatment at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) /100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting (wheat and barley).
- ◆ imidacloprid/metalaxyl/tebuconazole (GauchoXT) as seed treatment at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. Wheat, oats and barley only.
- ◆ imidacloprid/captan/carboxin (Enhance AW) at 4 oz per 100 lb seed. Wheat, oats, barley.
- ◆ thiamethoxam (Cruiser 5FS) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) /100 lb seed. Do not graze or feed livestock within 45 days of application.

Foliar treatment

Aphid control with foliar sprays is more successful when materials are applied during the warmer part of the day. Adequate coverage also is necessary: 5 gal water/a increases spray coverage and effectiveness.

- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/a. PHI 0 days. Do not apply more than 6 pints/a. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/a. For best control, applications must be made before aphids damage the plants. PHI 30 days. REI 12 hr. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.23 to 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year. Wheat only.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.16 to 0.3 lb ai/a (wheat only). PHI 14 days forage and hay, 30 days grain and straw. REI 24 hr. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat only.
- ◆ cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of

application. Do not feed straw within 30 days. Do not exceed 0.06 lb ai/a per season.

- ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ methomyl (Lannate SP) at 0.225 to 0.45 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/a per season. Do not exceed 4 applications per season. Wheat only.
- ◆ sulfoxyflor (Transform WG) at 0.023 to 0.047 lb ai/a. REI 24 hr. PHI 14 days grain or straw, 7 days grazing, forage, fodder, hay harvest. Retreatment interval 14 days. Limit 2 treatment per crop. Do not exceed 0.09 lb ai/a per year. Barley, triticale and wheat only.
- ◆ thiamethoxam (Actara) 0.0625 lb ai/a. PHI 21 days (barley only). Do not exceed 0.125 lb ai/a per season. Wait 5 days before placing beehives in a treated field. Barley only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.22 to 0.28 lb ai/a. PHI for forage or hay 14 days; grain and straw 28 days. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Barley thrips

Limothrips denticornis

Pest description and crop damage Black, yellowish, or reddish, winged or wingless, small insects about 0.0625 inch long that cause foliage to turn whitish or rusty. When abundant, they may injure flowers and reduce yields.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ azadirachtin (Aza-Direct, Ecozin 3EC) at 0.43 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Some formulations are 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.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a (wheat and triticale only). PHI 14 days also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.22 to 0.28 lb ai/a. PHI for forage or hay 14 days; grain and straw 28 days. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Brown wheat mite

Petrobia latens

Pest description and crop damage Young mites are red-orange; later, they become dark brown. Feeding gives foliage a mottled appearance and stunts plants. It has been a problem primarily on barley, but it also attacks wheat and other small grains, ryegrass, some legumes, onions, and carrots.

Management—chemical control

Foliar sprays

- ◆ chlorpyrifos (Lorsban Advanced) at 0.23 to 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year. Wheat only.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.16 to 0.3 lb ai/a. REI 24 hr. PHI: 14 days forage and hay, 30 days grain and straw. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat 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.
- ◆ dimethoate (Dimethoate 400) at 0.16 to 0.25 lb ai/a, PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Wheat only.
- ◆ gamma-cyhalothrin (Declare) at 0.015 lb ai/a. PHI 30 days. REI 24 hr. Maximum 0.03 lb ai/a per season. Suppression only. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.03 lb ai/a. Suppression only. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.

Small grain—Cereal leaf beetle

Oulema melanopus

Pest description and crop damage Adults are small beetles about 0.25 to 0.375 inch, with a metallic-blue head and wing covers, red pronotum, and yellow-orange legs. Larvae are yellow to yellow-brown with a dark mass of slimy fecal material on their backs.

Both adults and larvae feed on leaves. Feeding causes a characteristic stripping of the leaves.

Sampling and thresholds Treat when there are three larvae or eggs per plant up to the boot stage. After boot, treat at one larva per flag leaf.

Management—biological control

These insects are controlled easily by introduced parasitoids. The primary biocontrol agents (parasitoids) are two wasp species; *Tetrastichus julis* (a larval parasitoid) and *Anaphes flavipes* (an egg parasitoid).

Management—chemical control

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/a. PHI 0 days. Do not apply more than 6 pints/a. Some formulations are OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.008 to 0.014 lb ai/a. PHI 30 days. REI 12 hr. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season
- ◆ chlorpyrifos (Lorsban Advanced) at 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year. Wheat only.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.3 to 0.58 lb ai/a. REI 24 hr. PHI 14 days forage and hay, 30 days grain and straw. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat 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.
- ◆ cyfluthrin (Tombstone) at 0.016 to 0.028 lb ai/a (wheat only).

- PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ diflubenzuron (Dimilin 2L) at 0.0625 lb ai/a. PHI for grain and straw 50 days; forage 3 days; hay 15 days. REI 12 hr. One treatment per season.
 - ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
 - ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
 - ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
 - ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
 - ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.055 to 0.07 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
 - ◆ methomyl (Lannate SP) at 0.225 to 0.45 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/a per season. Do not exceed 4 applications per season. Wheat only.
 - ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
 - ◆ spinetoram (Radiant SC) at 0.0156 to 0.047 lb ai/a. PHI 21 day of grain or straw harvest; 3 days of forage, fodder or hay harvest. REI 4 hr. Do not exceed 0.141 lb ai/a per year. Limit 3 applications per year. Retreatment interval 4 days.
 - ◆ spinosad (Success, Entrust SC) at 0.031 to 0.094 lb ai/a. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Do not exceed 0.28 lb ai/a per year. Limit 3 treatments per year. Entrust SC is OMRI-listed for organic use.
 - ◆ zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a. PHI 14 days, also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.
 - ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.12 to 0.28 lb ai/a. PHI 14 days for forage or hay; 28 days for grain and straw. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Chinch bug

Blissus spp.

Pest description and crop damage A small black bug, 0.18 inch long, with a conspicuous black triangle on the outer margin of white wings. The nymphs have a white band that transverses the body. As the nymphs mature, their reddish bodies become darker.

Bugs cause damage through direct feeding. Removal of nutrients and obstruction of water transportation system causes the plant to become yellow and wilt. Initial injury occurs at or just below the soil level where the insect is most abundant. However, economic losses almost never occur in healthy grain fields.

Chinch bug damage to cereal grains is most evident in May through July. Adults move from their overwintering sites in bunchgrasses to

wheat and barley. The first generation chinch bug nymphs proceed to feed and develop on the cereal grains until these plants dry down. The nymphs then migrate to other suitable summer hosts.

Management—chemical control

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/a. PHI 0 days. Do not apply more than 6 pints/a. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not graze or forage within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 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.
- ◆ cyfluthrin (Tombstone) at 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ gamma-cyhalothrin (Declare) at 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Retreatment interval 3 days. Do not exceed 0.06 lb ai/a per season. Do not feed straw to meat or dairy animals within 30 days after last treatment.
- ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.098 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 14 days, also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.

Small grain—Cutworm and armyworm

Includes

Army cutworm (*Chorizagrotis auxiliaris*)

Variegated cutworm (*Peridroma saucia* and *Euxoa* spp.)

Wheat head armyworm (*Faronta diffusa*)

Pest description and crop damage Young plants often are damaged in early spring. Grain damaged by this insect was reported in recent years by barley and wheat growers in Washington and Idaho. Unfortunately, the damaged kernels were only detected after harvest. Infestations are usually too sporadic and isolated to justify any type of scouting or treatment program.

Management—chemical control

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/a. PHI

- 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ azadirachtin (Aza-Direct, Ecozin 3EC) at 0.43 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.
 - ◆ *Bacillus thuringiensis kurstaki* (Javelin) at 0.12 to 1.5 lb/a. OMRI-listed for organic use.
 - ◆ beta-cyfluthrin (Baythroid XL) at 0.008 to 0.019 lb ai/a. REI 12 hr. PHI 30 days. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
 - ◆ *Burkholderia* spp. (Venerate XC) at 1 to 8 qt per acre. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
 - ◆ chlorpyrifos (Lorsban Advanced) at 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year (wheat only).
 - ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.3 to 0.58 lb ai/a (wheat only). REI 24 hr. PHI 14 days forage and hay, 30 days grain and straw. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat only.
 - ◆ *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 0.016 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
 - ◆ gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
 - ◆ GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.8 lb ai/a. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/a per year. Armyworms only. Wheat and barley only.
 - ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.015 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
 - ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.33 lb ai/a per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
 - ◆ methomyl (Lannate SP) at 0.225 to 0.45 lb ai/a. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/a per season. Do not exceed 4 applications per season.
 - ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.049 to 0.078 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
 - ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
 - ◆ malathion (Gowan Malathion 8) at 1 to 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments per year.
 - ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed.
 - ◆ spinetoram (Radiant SC) at 0.023 to 0.047 lb ai/a. Do not exceed 0.141 lb ai/a per year. Limit 3 applications per year. Retreatment interval 4 days. PHI 21 days for grain and straw; 3 days for forage, fodder, or hay harvest. REI 12 hr.
 - ◆ spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Do not exceed 0.28 lb ai/a per year. Limit 3 treatments per year. Armyworms only. Entrust SC is OMRI-listed for organic use.
 - ◆ zeta-cypermethrin (Mustang) at 0.016 to 0.05 lb ai/a. PHI 14 days

for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.

- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.089 to 0.28 lb ai/a. PHI for forage or hay 14 days; grain and straw 28 days. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Grass bug

Includes

Black grass bug (*Labops hesperius*)
Pacific grass bug (*Irbisia pacifica*)

Pest description and crop damage Bug is grayish black, about 0.25 inch long, and somewhat pear-shape. Feeding causes pale spots on the leaves of cereals and, when severe, gives leaves a general yellowish, stippled appearance.

Infestations of this insect occasionally occur in volunteer grain or grain growing under poor soil or moisture conditions. It has not been a common problem in grain-growing areas. For more information about black grass bugs, look at University of Idaho CIS 1128 publication, available online: <http://info.ag.uidaho.edu/PDF/CIS/CIS1128.pdf>

Management—chemical control

Foliar sprays

- ◆ zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/a (wheat and barley). PHI 14 days – also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Wheat, triticale and barley only.

Small grain—Grass sheathminer

Cerodontha dorsalis and *C. occidentalis*

Pest description and crop damage Adult is a tiny fly, 0.18 inch long, dark with yellow on the head, body, and legs. Adults make feeding punctures on leaves. Larvae mine in leaves.

This insect has been found in wheat and barley and is reported to feed on a wide variety of grasses. This insect is not known to cause injury to wheat or barley.

Management—chemical control

Insecticides are not recommended.

Small grain—Grasshopper

Includes

Clearwinged grasshopper (*Camnula pellucida*)
Migratory grasshopper (*Melanoplus sanguinipes*)

Pest description and crop damage Both young and adults do damage. They feed on foliage, heads, or often on stems just beneath the heads, causing them to drop. They may attack any of the cereal crops.

Management—chemical control

Seed treatment

Seed treatment used on wheat and barley may provide early season protection from grasshoppers.

- ◆ imidacloprid (Gaucho 600F) at 1.2 to 2.4 fl oz per (0.047 to 0.094 lb ai) /100 lb seed to provide early-season protection. Do not graze or feed livestock on treated areas within 45 days after planting. To reduce early season damage caused by grasshoppers, Gaucho 600 treated seed may be planted as a 50 to 60 foot border around the edges of the field.

- ◆ thiamethoxam (Cruiser 5FS) at 0.75 to 1.33 fl oz (0.03 to 0.052 lb ai) /100 lb seed. Do not graze or feed livestock within 45 days of application.

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/a. PHI 0 days. Do not apply more than 6 pints/a. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
- ◆ chlorpyrifos (Lorsban Advanced) at 0.23 to 0.47 lb ai/a. PHI 14 days forage and hay; 28 days grain and straw. REI 24 hr. Do not exceed 2 treatments per acre per year. Wheat only.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.16 to 0.3 lb ai/a (wheat only). REI 24 hr. PHI 14 days forage and hay, 30 days grain and straw. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat only.
- ◆ chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/a. REI 4 hr. PHI 1 day. Limit 4 treatments. Retreatment interval 7 days. Do not exceed 0.2 lb ai of chlorantraniliprole per acre per year.
- ◆ cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ diflubenzuron (Dimilin 2L) at 0.015 to 0.031 lb ai/a. PHI for grain and straw 50 days; forage 3 days; hay 15 days. REI 12 hr. One treatment per season.
- ◆ dimethoate (Dimethoate 400) at 0.375 lb ai/a, PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/a per season. Wheat only.
- ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
- ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ malathion (Gowan Malathion 8) at 1.0 to 1.25 lb ai/a. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 2 applications per season.
- ◆ *Nosema locustae* (Nolo Bait)—Apply as manufacturer directs. OMRI-listed for organic use.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- ◆ spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/a. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Do not exceed 0.28 lb ai/a per year. Limit 3 treatments per year. Entrust SC is OMRI-listed for organic use.

- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 14 days also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.12 to 0.28 lb ai/a. PHI for forage or hay 14 days; grain and straw 28 days. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Haanchen barley mealybug

Trionymus haancheni

Pest description and crop damage Adult females are small (0.2 inch long), elongate, oval, segmented insects often covered with white, waxy secretions that extend as filaments along the edges of the body. Nymphs resemble small adults. Eggs are laid in cottony sacs usually in the lower part of the plants. Adult males are the only winged instar. All stages occur at the soil surface or under the leaf sheaths surrounding the stems.

Mealybugs harm plants through feeding damage, honeydew accumulation, and possible toxin injection. Mealybug feeding causes yellowing and browning of foliage. Economic damage has been observed in barley and wheat.

Haanchen barley mealybug has only been documented conclusively in California in the 1960s, Idaho since 2003, and Montana and Washington since 2005. It was also recently reported causing damage in barley fields of Alberta in Canada. Many aspects of this insect's biology still need to be understood before an effective management plan can be implemented.

Management—chemical control

Insecticides are not currently registered for control of these pests.

Small grain—Harvester ant

Pogonomyrmex spp.

Pest description and crop damage Large reddish ants found east of the Cascades. They build soil and pebble mounds and destroy vegetation around the mounds. May sting viciously when disturbed.

Management—chemical control

Insecticide control is not recommended

Small grain—Hessian fly

Mayetiola destructor

Pest description and crop damage Adult is a delicate, mosquito-like fly with a reddish brown to dusky black body. Insects overwinter in puparial “flaxseed” stage in stubble, volunteer wheat, and fields seeded before mid October.

Larval feeding at or near the crown stunts plants and reduces yield. Greatest damage is usually to wheat, but barley and rye also are attacked. Oats are free of this pest.

Management—cultural control

Deep plowing soon after harvest is helpful if soil conditions permit this practice. Direct seeding systems in the drylands of Washington and Idaho prevent deep plowing. Follow cultural practices that lead to optimum production. Winter wheat seeded after mid October is usually free of this pest. Spring wheat seeded behind failed fall-seeded wheat is especially prone to attack.

Management—chemical control

Seed treatments

Seed treatments applied to wheat and barley seed may help control Hessian fly.

- ◆ clothianidin (NipsIt Inside) at 0.07 lb ai/100 lb seed on-farm application. Do not exceed 0.2 lb ai/a clothianidin per year. Wheat only
- ◆ imidacloprid (Gaucho 600F) at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) per 100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting.
- ◆ thiamethoxam (Cruiser 5FS) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) per 100 lb seed. Do not graze or feed livestock within 45 days.

Foliar sprays

- ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/. PHI 30 days. REI 24 hr. Maximum 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days. Apply when adults emerge.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Apply when adults emerge. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
- ◆ lambda-cyhalothrin+tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Make applications when adults emerge. Barley only.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.

Small grain—Leafminer

Phytomyza nigra

Pest description and crop damage Larvae mine the lower leaves of fall-seeded wheat, barley, and rye during the spring following seeding. New spring growth appears to mask injury these larvae may cause. The larvae are heavily parasitized by other insects, and this may aid in keeping this insect at relatively low numbers.

Management—chemical control

Insecticide control is rarely needed.

Foliar sprays

- ◆ azadirachtin (Aza-Direct, Ecozin 3EC) at 0.43 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.

Small grain—Omnivorous leafhopper

Cnephasia longana

Pest description and crop damage Larvae are about 0.625 inch long when mature, with a tan head; the body is yellowish or gray with a lighter stripe on each side of the back.

This is a pest of vetch; occasionally it attacks wheat heads in fields where vetch grows. It is most common west of the Cascades.

Management—chemical control

Damage rarely is enough to justify chemical control, except in the Willamette Valley of Oregon. Some insecticides are registered in Oregon to control this pest; see labels for rates.

Small grain—Sawfly

Pachynematus spp.

Pest description and crop damage Green, caterpillar-like larvae feed on foliage and developing heads. They have been found only on wheat, but they may attack other cereals. They rarely are sufficiently abundant to require control.

Management—chemical control

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.3 to 0.58 lb ai/a (wheat only). PHI 14 days forage and hay, 30 days grain and straw. REI 24 hr. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat only.
- ◆ cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ gamma-cyhalothrin (Declare) at 0.0125 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.025 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 14 days also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.25 lb ai/a per year. Barley, wheat and triticale only.

Small grain—Slug

Management—chemical control

- ◆ metaldehyde baits—
 - Deadline Bullets, Deadline M-Ps at 10 to 40 lb/a.
 - Durham Metaldehyde Granules 7.5 at 10 lb/a. *Barley, oats, and wheat.*
 - Metaldehyde 4 Bait at 30 to 60 lb/a.

Small grain—Stink bug

Pest description and crop damage Green or brown shield-shaped bugs feeding on developing grain heads.

Management—chemical control

Foliar sprays

- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. PHI 14 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/a per season. Wheat and triticale.

- ◆ azadirachtin (Aza-Direct, Ecozin 3EC) at 0.43 lb ai/a. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/a. PHI 0 days. Do not apply more than 6 pints/a. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/a. PHI 30 days. REI 12 hr. Do not forage or graze within 3 days of application. Retreatment interval 3 days. Do not exceed 0.038 lb ai/a per season.
- ◆ chlorpyrifos/gamma-cyhalothrin (Cobalt) at 0.44 to 0.58 lb ai/a (wheat only). PHI 14 days forage and hay, 30 days grain and straw. REI 24 hr. Not more than 2 applications per year. Do not exceed 1 lb ai/a chlorpyrifos per season. Wheat only.
- ◆ cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/a (wheat only). PHI 30 days. Pre-grazing or foraging interval 3 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/a per season.
- ◆ gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/a. PHI 30 days. REI 24 hr. Do not apply more than 0.03 lb ai/a per season. Do not graze or forage within 7 days of application. Do not feed straw within 30 days.
- ◆ lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/a. PHI 30 days. REI 24 hr. Do not graze or forage within 7 days of application. Do not feed straw within 30 days of last treatment. Do not exceed 0.06 lb ai/a per season.
- ◆ lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/a. PHI 30 days. REI 24 hr. Do not exceed 0.11 lb ai/a tebuconazole or 0.06 lb ai/a lambda cyhalothrin per season. Feeding restrictions apply. Do not exceed 8 fl oz/a or 0.139 lb ai/a per season.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/a. PHI 30 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Feeding restrictions.
- ◆ lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/a. PHI 30 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/a lambda-cyhalothrin or 0.125 lb ai/a thiamethoxam per season. Barley only.
- ◆ pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a. PHI 14 days, also for forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/a per year. Barley, wheat and triticale only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.22 to 0.28 lb ai/a. PHI 14 days for forage and hay; 28 days for grain and straw. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Wheat curl mite

Eriophyes tulipae

Pest description and crop damage Tiny eriophyid mite, not visible to the naked eye, causes proliferation of florets and distortion of wheat heads. The pest is a vector of wheat streak mosaic. Late-planted spring and early-planted fall grains are susceptible to damage.

Management—chemical control

Insecticide control is not recommended.

Small grain—Wheat jointworm

Harmolita tritici

Pest description and crop damage Jointworm is the larva of a wasp resembling a small, winged black ant. Larvae live in stems and feed on sap, causing hard, woody galls usually above the second or third joints. They attack only wheat. They have not been observed as a pest for many years.

Management—cultural control

Follow practices which lead to vigorously growing, strong stands of wheat. Deep plowing in late summer or early fall is suggested in situations where this practice can be followed.

Management—chemical control

Insecticides have not been effective against this insect. Insecticide control is not recommended.

Small grain—Wheat stem maggot

Meromyza pratorum and *Meromyza saltatrix*

Pest description and crop damage The adult fly is light to dark green or green-yellow with a dark stripe on the dorsum of thorax. This insect's presence is recognized most easily by larval damage: white heads on headed culms. Larvae sometimes attack young tillers, cutting off the central shoot. Occasionally, larvae attack heads and destroy floral parts or developing seed.

They are seen most often on wheat but also attack barley, rye, and oats. These insects have severely damaged spring barley in Klamath Falls, OR.

Management—chemical control

Insecticides are not currently labeled for control of these pests.

Small grain—Wheat stem sawfly

Cephus cinctus

Pest description and crop damage Primarily a pest in Montana.

Management—chemical control

Foliar sprays

- ◆ zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/a . PHI 14 days, also for forage and hay. REI 12 hr. Use for adults. Retreatment interval 14 days. Do not exceed 0.25 lb ai/a per year. Barley, wheat and triticale only.
- ◆ zeta-cypermethrin/chlorpyrifos (Stallion) at 0.22 to 0.28 lb ai/a. PHI 14 days for forage or hay; 28 days for grain and straw. REI 24 hr. Retreatment interval 14 days. Do not allow meat or dairy animals to graze within 28 days of application. Do not exceed 0.05 lb ai/a zeta-cypermethrin or 0.5 lb ai/a chlorpyrifos per season. Wheat only.

Small grain—Wheat strawworm

Harmolita grandis

Pest description and crop damage Overwinters in straw and emerges in February or March as a shiny, black, wingless insect. Eggs are laid in or near the developing wheat head. The wall of the short stem around the larvae enlarges and hardens to form a gall. Second-generation adults are winged and lay eggs in wheat stems about the time wheat is in boot stage. Larvae develop in the center or in the wall of the stem, which usually shows no external evidence of injury.

Management—cultural control

This insect is throughout most of the Pacific Northwest but has not been a serious pest. Apparently, only wheat is damaged. Adults

may lay eggs in barley, oats, and rye, but larvae can complete development only on wheat. Avoid growing wheat within 125 ft of wheat straw or stubble of previous season, because the spring form is wingless and does not migrate any distance. Thoroughly plowing under stubble and clean summer fallow reduce insect populations.

Management—chemical control

Insecticide control is not recommended.

Small grain—Wireworm

Primarily Great Basin wireworm (*Ctenicera pruinina*) and sugar beet wireworm (*Limonius californicus*)

Pest description and crop damage Larvae (wireworms) are up to 0.75 inch long, yellowish, smooth-bodied, and shiny. In the case of fall-sown wheat, larvae burrow into kernels or leaf whorl above seed. In spring seedlings, larvae attack kernels or underground portions of plant after sprouting. Damage is more severe in cool, wet spring weather.

Management—chemical control

Wireworms are usually a localized problem. Be sure to use seed treatments for wheat and barley. Wheat may tolerate up to a 20% stand reduction to wireworms without showing a loss, according to some research. **Warning:** Treated seed must not be used for food or livestock feed. If a proprietary seed dressing is used, follow manufacturer's directions.

Seed treatments

- ◆ clothianidin/metalaxyl/metconazole (NipsIt Suite) at 5 to 7.5 fl oz (0.01 to 0.015 lb ai) /cwt seed. Do not exceed 6.4 oz ai/a clothianidin per season. Barley, oats and wheat only.
- ◆ clothianidin (NipsIt Inside) at 0.01 to 0.07 lb ai/100 lb seed on-farm application. Do not exceed 0.2 lb ai/a clothianidin per year.
- ◆ imidacloprid (Gaucho 600F, Sativa IM RTU) at 0.005 to 0.01 lb ai/100 lb seed (0.13 to 0.26 fl oz). Do not graze or feed livestock on treated areas within 45 days after planting. Wheat, barley, oats, rye and triticale.
- ◆ imidacloprid/metalaxyl/tebuconazole (GauchoXT) as seed treatment at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. Wheat, oats and barley only.
- ◆ thiamethoxam (Cruiser 5 FS, Warden Cereals 360) at 0.19 to 0.25 fl oz (0.007 to 0.01 lb ai) per 100 lb seed (wheat and barley). Do not graze or feed livestock with 45 days of application. Other seed protectants containing thiamethoxam as the only insecticide include: Cruiser Maxx and Cruiser Vibrance Quattro.
- ◆ thiamethoxam/difenoconazole/mefenoxam/fludioxonil/sedaxane (Cruiser Vibrance Quattro) at 0.02 to 0.032 lb ai/100 lb seed. Feeding restrictions apply.

Fumigants

- ◆ 1,3 dichloropropene or 1,3-dichloropropene/chloropicrin (Telone II or Telone C17)—Preplant fumigate. Suppression only.

Sugar Beet Pests

Erik J. Wenninger

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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.

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

Sugar beet—Aphid

Black bean aphid (*Aphis fabae*)

Green peach aphid (*Myzus persicae*)

Pest description and crop damage The black bean aphid is a dark-bodied aphid, 0.0625 inch long, that sporadically reaches damaging levels, most often late in the season. Infestations usually occur as scattered hot spots or along edges rather than uniformly across the entire field. Colonies can produce massive amounts of honeydew, which causes a black, sooty mold to cover the leaves. Black bean aphids can also vector virus diseases, but they are less important as virus vectors than green peach aphids.

The green peach aphid is yellowish green and teardrop-shaped. Its economic impact is primarily as a vector of virus diseases rather than by feeding injury through sucking sap.

Scouting and thresholds No formal economic thresholds exist for green peach aphid insecticide treatment decisions. If natural enemies are absent, consider an insecticide application if bean aphids are on most leaves and if colonies cover 20 to 40 percent of leaf surface.

Management—biological control

Aphids are attacked by a large variety of predatory and parasitic insects as well as by fungal diseases. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications.

- ◆ *Beauveria bassiana* (BotaniGard 22WP, BotaniGard ES, Mycotrol ESO, Mycotrol O, Mycotrol WPO, and others – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray for signs of effectiveness. Begin treatment at first appearance of pest. Reapply as necessary. OMRI-listed for organic use.
- ◆ *Chromobacterium subsugae* (Grandevo, Grandevo PTO, Grandevo WDG – insect-killing bacterium) at 0.6 to 0.9 lb ai/a. REI 4 hr. Must be mixed with water and applied as a foliar spray with ground or aerial equipment for conventional spraying or by chemigation. OMRI-listed for organic use.

Management—chemical control

- ◆ aldicarb (AgLogic 15G, AgLogic 15GG) at 1.05 to 2.1 lb ai/a. PHI 90 days, or 120 days if tops are fed to livestock. Do not use tops as food for humans. Do not make more than one at-planting and two postemergence applications per crop. Do not exceed a total of 4.95 lb ai/a per season. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil.

- *At planting* (or within 1 week before planting)—Drill granules 1 to 3 inches below seedline. Granules can be placed into the seed furrow if rate does not exceed 1.05 lb ai/a. Repeat applications may be required for continued protection against aphids vectoring viruses.
- *Postemergence*—Granules may be applied to both sides of plant row and immediately worked into the soil or covered with soil. Furrow irrigation is another method: side-dress granules 4 to 8 inches to water-furrow side of plant row and at furrow depth. Irrigate soon after application. Apply within 60 days of planting. Repeat applications may be required for continued protection against aphids vectoring viruses. Do not apply postemergence if 4.05 to 4.95 lb ai/a was applied at time of planting or 1 week prior to planting.
- ◆ alpha-cypermethrin (Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. Do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Azatin XL) at 0.021 to 0.033 lb ai/a. For suppression only.
 - (Aza-Direct) at 0.0123 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy infestation.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7-10 days.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilute in a minimum of 30 gal of water per acre. May be applied by air at 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ *Burkholderia* spp. (Venerate XC – heat-killed insecticidal bacteria)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ chlorpyrifos (Drexel Chlorpyrifos 4E AG, Govern 4E, Lorsban 4E, Warhawk, and others) at 0.5 to 1 lb ai/a broadcast –or– Lorsban Advanced, Vulcan at 0.469 to 0.939 lb ai/a broadcast. PHI 30 days. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment. FIFRA Section 2(ee) recommendation.
- ◆ chlorpyrifos (Govern 4E, Lorsban 4E, Warhawk, and others) at 0.33 to 0.67 lb ai/a –or– Lorsban Advanced at 0.313 to 0.626 lb ai/a. Apply as a 5- to 7-inch band, lightly incorporating mechanically or with irrigation. FIFRA Section 2(ee) recommendation.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.219 to 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ clothianidin (NipsIt INSIDE)—For black bean aphid. Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ imidacloprid (Agrisolutions Nitro Shield, Agristar Macho 600 ST, Attendant 480 FS, Access Insecticide Seed Treatment, Dyna-Shield Imidacloprid 5, Gaucho 480 Flowable, Gaucho 600 Flowable, Senator 600FS, Sharda 5SC, and others)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.225 to 0.9 lb ai/a. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop. Do not apply more than 10 times per crop. May be applied by overhead sprinkler chemigation to control aphids, in which case highest listed rate should be used with 0.1 to 0.2 inches of water per acre.
- ◆ mineral oil (470 Supreme Spray Oil, BioCover, and others)—See label for rates. Some formulations are OMRI-listed for organic use.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. REI 48 hr. PHI 2 days. Recommendation as permitted under FIFRA Section 2(ee). Do not apply more than 4.7 lb ai/a per season. Do not apply more than five times per season.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ oxydemeton methyl (MSR Spray Concentrate) at 0.45 to 0.6 lb ai/a. Do not apply more than once per season. Do not harvest beets or use beet tops for feed or forage within 30 days of last application.
- ◆ phorate (Thimet 20G and others)—as follows:
 - *At planting*—Apply at 0.68 to 0.9 oz ai/1,000 row feet. PHI 30 days. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Drill to side of seed or band over seed. Only one application per cropping season.
 - *Postemergence*—Apply at 0.98 to 1.5 lb ai/a. Apply to foliage when plants are dry. Only one postemergence treatment per season. PHI 30 days.
- ◆ potassium salts of fatty acids (Des-X, Kopa, and M-Pede)—See label for rates. For green peach aphid, apply M-Pede only in tank mix with labeled companion insecticide; see label about tank mixing. PHI 0 days. Some formulations are OMRI-listed for organic use.
 - potassium silicate (Sil-Matrix) at 1.5 to 3 lb ai/a—For suppression only. Do not apply more than 21 lb ai/a per season. PHI 0 days. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, and Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ sodium tetraborohydrate decahydrate (Prev-Am Ultra) applied as a 0.8% solution, 40 to 50 gal per acre. Spray every 7 to 10 days as necessary.
- ◆ spirotetramat (Movento and Movento HL) at 0.07 to 0.14 lb ai/a. For black bean aphid control only. PHI 28 days. Maximum 0.28 lb ai/a per crop season.
- ◆ sulfoxafloer (Transform WG) at 0.023 to 0.047 lb ai/a. Do not apply more than 0.266 lb ai/a per year. PHI 7 days.
- ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter Smartbox 20G, Counter 15G Lock'n Load, Counter 15G Smartbox)—One application per year. Do not place granules in direct contact with the seed. Do not exceed 2 lb ai/a. PHI 110 days for at planting banded, at planting in-furrow, or postemergence applications; PHI 150 days for at planting knifed-in application.

- *At planting* (several methods)—Apply at 0.6 to 1.2 oz ai/1,000 row feet, in 5- to 7-inch band over the row, and lightly incorporate.
 - * Apply at 1.2 oz ai/1,000 row feet, modified in-furrow, 2 to 3 inches behind seed drop zone (after some soil has covered the seed).
 - * Apply at 1.2 oz ai/1,000 row feet, knifed-in: drill granules 2 inches to the side of the seed and 2 to 4 inches below the seed.
- *Postemergence*—Apply at 0.6 to 1.2 oz ai/1,000 row feet, in 5- to 7-inch band over the row, and lightly incorporate.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. Variable control depending on aphid species. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground. Aphid control may be variable depending on species present and host-plant relationships.

Sugar beet—Armyworm

Beet armyworm (*Spodoptera exigua*)

Bertha armyworm (*Mamestra configurata*)

Western yellowstriped armyworm (*Spodoptera praefica*)

Pest description and crop damage Armyworms occasionally are severe defoliators, especially in western Idaho. Damage appears as skeletonized leaves with only leaf veins and petioles remaining. Armyworms are related closely to cutworms but generally are slightly larger, more brightly colored, and actively feed on plants during the day. When infestations become dense and crowded, larvae migrate together from field to field; sugar beets adjoining infested alfalfa hay fields or cereals may be completely defoliated by migrating armyworms.

Beet armyworms are dull green caterpillars with a dark, broad stripe along each side and many smaller, light wavy lines down the back. They are about 1.25 inches long when mature.

Bertha armyworms are highly variable, from light yellow-green to gray-black, with a yellow-orange stripe along the side that divides the caterpillar body into a dark upper half and a pale bottom half. They are about 1.25 inches long when mature.

Western yellowstriped armyworms have wide, velvety black stripes along the back with many narrower, bright yellow stripes along the sides. They are about 1.5 inches long when mature.

Scouting and thresholds No formal economic thresholds exist for armyworm insecticide treatment decisions in sugar beets. Consider insecticide application if field scouting shows that infestations average one armyworm larva per plant early in the season. Older plants can tolerate considerable defoliation without any economic loss of root yield or sucrose content.

Management—biological control

Armyworms commonly are attacked by parasitic wasps and flies that can help keep infestations in check. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications.

- ◆ *Bacillus thuringiensis aizawai* (Agree WG, XenTari – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. Biological insecticide most effective against small, newly hatched

larvae. No contact action; larvae must eat treated leaves. Use a spreader–sticker. REI 4 hr. Some formulations are OMRI-listed for organic use.

- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP, Crymax, Deliver, Dipel DF, Javelin WG, and others – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. REI 4 hr. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader–sticker. Some formulations OMRI-listed for organic use.
- ◆ *Chromobacterium subsugae* (Grandevo, Grandevo PTO, Grandevo WDG – insect-killing bacterium) at 0.3 to 0.9 lb ai/a. REI 4 hr. Must be mixed with water and applied as a foliar spray with ground or aerial equipment for conventional spraying or by chemigation. OMRI-listed for organic use.
- ◆ GS-omega/kappa-Hxtx-Hv1a (Spear LEP – peptide derived from spider venom)— See label for rates. Tank mix with *Bacillus thuringiensis* products (Bts) to enhance control. PHI 0 days.
- ◆ *Spodoptera exigua* multinucleopolyhedrovirus (SeMNPV) strain BV-0004 (Spexit) for control of beet armyworm at 0.11 to 0.28 lb ai/a. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

Management—chemical control

- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Azatin XL) at 0.01 to 0.033 lb ai/a. Foliar application against larvae.
 - (Aza-Direct) at 0.0123 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy pest infestation.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7-10 days.
- ◆ alpha-cypermethrin (Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. Do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ *Burkholderia* spp. (Venerate XC – heat-killed insecticidal bacteria)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ carbaryl (Carbaryl 4L, Sevin 4F, Sevin 5 Bait, Sevin XLR Plus, Sevin 80 Solupak, Bran For Grasshoppers, and others) at 0.6 to 1.5 lb ai/a. PHI 28 days. For Carbaryl 4L, Sevin 4F, Sevin 5 Bait, and Sevin XLR Plus, do not apply more than a total of 3 lb ai/a per crop. For Sevin 80 Solupak, do not apply more than 4 lb ai/a per crop. For Bran for Grasshoppers, do not apply more than 1.2 lbs ai/a per crop. OMRI-listed for organic use.
- ◆ canola oil/garlic oil/capsicum oleoresin extract (Captive Prime)— See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ chlorantraniliprole (Coragen) at 0.045 to 0.065 lb ai/a. PHI 1 day. REI 4 hr. Apply no more than 4 applications per crop, no more than 0.2 lb ai per acre per year. Minimum interval between treatments is 3 days.
- ◆ chlorpyrifos—
 - For yellowstriped armyworm (several methods):
 - * (Eraser, Govern 4E, Lorsban 4E, Lorsban 75 WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.5 to 1 lb ai/a broadcast –or– Lorsban Advanced,

- Vulcan at 0.469 to 0.939 lb ai/a broadcast. PHI 30 days. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
 - * (Eraser, Hatchet, Govern 4E, Lorsban 4E, Lorsban 75 WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.33 to 0.67 lb ai/a band *–or–* Lorsban Advanced, Vulcan at 0.313 to 0.626 lb ai/a band. Apply as a 5- to 7-inch band, lightly incorporating mechanically or with irrigation.
- For beet armyworm (several methods):
 - * (Chlorpyrifos 4E, Eraser, Govern 4E, Lorsban 4E, Lorsban 75 WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.75 to 1 lb ai/a broadcast *–or–* Lorsban Advanced, Vulcan at 0.704 to 0.939 lb ai/a broadcast.
 - * (Eraser, Hatchet, Lorsban 4E, Lorsban 75 WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.5 to 0.67 lb ai/a *–or–* Lorsban Advanced, Vulcan at 0.469 to 0.626 lb ai/a. Apply as a 5- to 7-inch band, lightly incorporating mechanically or with irrigation.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Aids in control. Apply as necessary but do no more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water to cover uniformly (at least 2 gal/a water).
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.225 to 0.9 lb ai/a. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop. Do not apply more than 10 times per crop. May be applied by overhead sprinkler chemigation to control beet armyworm and western yellowstriped armyworm, in which case highest listed rate should be used with 0.1 to 0.2 inches of water per acre.
- ◆ methoxyfenozide (Inspirato 2F, Intrepid 2F, Invertid 2F, Troubadour, Withstand, Zylor) at 0.12 to 0.25 lb ai/a. Apply at egg hatch or when signs of feeding occur. PHI 7 days.
- ◆ methoxyfenozide and spinetoram (Intrepid Edge) at 0.11 to 0.28 lb ai/a. Apply at egg hatch or first signs of feeding. PHI 7 days.
- ◆ mineral oil (470 Supreme Spray Oil, BioCover, and others)—See label for rates. Some formulations are OMRI-listed for organic use.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. PHI 2 days. REI 48 hr. Recommendation as permitted under FIFRA Section 2(ee). Do not apply more than 4.7 lb ai/a per season.
- ◆ neem oil (NimBioSys, Terraneem EC, and others)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ sodium tetraborohydrate decahydrate (Prev-Am Ultra) applied as a 0.4% solution for beet armyworm only, 40-50 gal/a. Spray every 7 to 10 days as necessary.
- ◆ soybean oil/garlic oil/capsicum oleoresin extract (Captiva)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- ◆ spinosad
 - (Blackhawk) at 0.051 to 0.079 lb ai/a. Do not apply fewer than 7 days apart. Do not apply more than 0.33 lb ai per crop. PHI 3 days.
 - (Entrust, Entrust SC) at 0.075 to 0.15 lb ai/a. Do not apply fewer than 7 days apart. Do not apply more than four times per crop or apply more than 0.33 lb ai/a per crop. PHI 3 days. OMRI-listed for organic use.
 - (Radiant SC) at 0.05 to 0.0625 lb ai/a, excluding western yellowstriped armyworm. Do not apply more than 0.25 lb ai/a per crop. PHI 7 days.
 - (Success) at 0.025 to 0.05 lb ai/a. Do not apply more than four times per crop or 0.45 lb ai/a per crop. PHI 3 days.
- ◆ triphenyltin-hydroxide (Agri Tin)—See label for rates. For suppression only. PHI 21 days. REI 48 hr.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Beet leafhopper

Circulifer tenellus

Pest description and crop damage Light yellow-green to gray-brown wedge-shaped body about 0.125 inch long. These readily crawl and jump as nymphs or jump and fly as adults. They are most important as a vector of curly top virus; they are seldom numerous enough to cause feeding injury through sap sucking. Not all leafhoppers found in sugar beets are the true beet leafhopper.

Scouting and thresholds No formal economic thresholds exist for beet leafhopper insecticide treatment decisions.

Management—cultural control

Manage curly top by planting approved resistant varieties rather than solely attempting to kill the highly mobile, winged adult.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard 22WP, BotaniGard ES, Mycotrol ESO, Mycotrol O, Mycotrol WPO – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray for signs of effectiveness. Begin treatment at first appearance of pest. Reapply as necessary. OMRI-listed for organic use.

Management—chemical control

- ◆ aldicarb (AgLogic 15G, AgLogic 15GG) at 2.1 to 3 lb ai/a. PHI 90 days, 120 days if tops are fed to livestock. Do not use tops as food for humans. Do not make more than one at-planting and two postemergence applications per crop. Do not exceed a total of 9.5 lb ai/a per season. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil.
 - At planting (or within 1 week prior)—Drill granules 1 to 3 inches below seed line. Granules can be placed into the seed furrow if rate does not exceed 1.05 lb ai/a. Repeat applications may be required for continued protection against leafhoppers vectoring viruses.
 - Postemergence (multiple methods)—a) Apply granules to both sides of plant row and immediately work into the soil or cover with soil; b) For furrow irrigation, side-dress granules 4 to 8 inches to water-furrow side of plant row and at furrow depth. Irrigate soon after application. Apply within 60 days

- after planting. Repeat applications may be required for continued protection against leafhoppers vectoring viruses. Do not make any postemergence applications if 4.05 to 4.95 lb ai/a was applied at planting or within 1 week prior to planting.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Aza-Direct) at 0.0123 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy infestation.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7-10 days
 - ◆ carbaryl (Carbaryl 4L, Sevin 4F, Sevin XLR Plus, Sevin 80 Solupak, and others) at 1 to 1.5 lb ai/a. PHI 28 days. For Carbaryl 4L, Sevin 4F, and Sevin XLR Plus, do not apply more than a total of 3 lb ai/a per crop. For and Sevin 80 Solupak, do not apply more than 4 lb ai/a per crop.
 - ◆ canola oil/garlic oil/capsicum oleoresin extract (Captiva Prime)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
 - ◆ clothianidin (NipsIt INSIDE)—Application only by commercial seed treaters; no on-farm seed-treatment application.
 - ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment application.
 - ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
 - ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.118 to 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
 - ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Apply as necessary but no more than 0.15 lb ai/a per season.
 - ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
 - ◆ imidacloprid (Agrisolutions Nitro Shield, Agristar Macho 600 ST, Attendant 480 FS, Axxess Insecticide Seed Treatment, Dyna-Shield Imidacloprid 5, Gaucho 480 Flowable, Gaucho 600 Flowable, Senator 600FS, Sharda 5SC, and others)—Application only by commercial seed treaters; no on-farm seed-treatment application.
 - ◆ kaolin (Surround CF and Surround WP) at 5.94 to 11.88 lb ai/a for Surround CF and 23.75 to 47.5 lb ai/a for Surround WP. For suppression only. Product forms a barrier film that acts as a protectant; apply before infestations develop and continue on a 7 to 14 day schedule for the duration of the infestation. Surround WP is OMRI-listed for organic use.
 - ◆ mineral oil (JMS Stylet Oil and PureSpray Green)—See label for rates. PHI 0 days. Some formulations are OMRI-listed for organic use.
 - ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a by air or on the ground. PHI 2 days. REI 48 hr. Do not apply more than 4.7 lb ai/a per year.
 - ◆ oxydemeton-methyl (MSR Spray Concentrate) at 0.45 to 0.6 lb ai/a. PHI 30 days. Do not apply more than once per season. Do not harvest beets or use beet tops for feed or forage within 30 days of last application.
 - ◆ phorate—
 - At planting (Thimet 20G and others)—Apply at 0.68 to 0.9 oz ai/1,000 row ft. PHI 30 days. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Drill to side of seed or band over seed. No more than one application per cropping season.
 - ◆ potassium salts of fatty acids (M-Pede)—See label for rates. PHI 0 days. Some formulations are OMRI-listed for organic use.
 - ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
 - ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
 - ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
 - ◆ sodium tetraborohydrate decahydrate (Prev-Am Ultra) applied as a 0.8% solution, 40 to 50 gal per acre. Spray every 7 to 10 days as necessary.
 - ◆ soybean oil/garlic oil/capsicum oleoresin extract (Captiva)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
 - ◆ sulfoxaflor (Transform WG)—at 0.047 to 0.086 lb ai/a. Do not apply more than 0.266 lb ai/a per year. PHI 7 days.
 - ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter 20G Smartbox, Counter 15G Lock'n Load, Counter 15G Smartbox)—One application per year. Do not place granules in direct contact with the seed. Do not exceed 2 lb ai/a. PHI 110 days for at planting banded, at planting in-furrow, or postemergence applications; PHI 150 days for at planting knifed-in application.
 - At planting (several methods)—
 - * Apply at 0.6 to 1.2 oz ai/1,000 row, in 5- to 7-inch band over the row and lightly incorporate to 1 inch.
 - * Apply at 1.2 oz ai/1,000 row feet, modified in-furrow, 2 to 3 inches behind seed drop zone after some soil has covered the seed.
 - * Apply at 1.2 oz ai/1,000 row feet knifed-in. Drill granules 2 inches to the side of the seed and 2 to 4 inches below the seed.
 - Postemergence—Apply at 0.6 to 1.2 oz ai/1,000 row feet, in 5- to 7-inch band over the row, and lightly incorporate.
 - ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.
 - ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Blister beetle

Epicauta spp. and others

Pest description and crop damage Gray, black, spotted, or striped beetles 0.5 to 1 inch long, with conspicuous necks and soft, rounded wing covers that leave the tip of the abdomen exposed. Larvae are beneficial predators of grasshopper eggs; damaging populations of leaf-feeding adult blister beetles are most likely where sugar beet fields immediately border grasshopper breeding areas.

Scouting and thresholds No formal economic thresholds exist for blister beetle insecticide treatment decisions. They seldom are an economic problem.

Management—chemical control

- ◆ azadirachtin/pyrethrins (Azera and Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foiar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Carrion beetle

Silpha bituberosa

Pest description and crop damage Flattened, shiny black larva has a distinctly segmented body that tapers from head to abdomen. Adults are dull black, flattened, oblong-oval shaped, with ridges running lengthwise down wing covers. Feeding by larvae and adults appears as ragged or crushed leaf edges, especially on plants along field margins where adults overwinter.

Scouting and thresholds No formal economic thresholds exist for carrion beetle insecticide treatment decisions. They rarely cause economic injury.

Management—cultural control

Prevent buildup by eliminating weedy host plants (commonly lambsquarters and pigweed).

Management—chemical control

- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.225 to 0.9 lb ai/a. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop or apply more than 10 times per crop.

Sugar beet—Cutworm

Subterranean species include

Black cutworm (*Agrotis ipsilon*)

Glassy cutworm (*Apamea devastator*)

Redbacked cutworm (*Euxoa ochrogaster*)

Climbing species include

Army cutworm (*Euxoa auxiliaris*)

Spotted cutworm (*Xestia c-nigrum*)

Variegated cutworm (*Peridroma saucia*)

Pest description and crop damage Several species can cause significant damage to seedling-stage sugar beets, especially in fields where weedy spots or plant debris on the soil surface serve as sites for cutworm overwintering or early-season egg laying. Cutworms

generally are nocturnal, remaining by day just under the soil surface; so, often they are not seen until after the plant already has been damaged.

Cutworm larvae are about 1 inch when mature and vary in color from light gray to dark brown, with faint stripes or fine mottles on their smooth, hairless, soft bodies. They curl into a motionless C-shape when disturbed.

Subterranean species feed on roots and stems, cutting off plants at the soil surface. Climbing species hide during the day in soil and either cut off plants at the soil surface or feed in the crown on newest leaves and stems.

Scouting and thresholds No formal economic thresholds exist for cutworm insecticide treatment decisions in sugar beets. Infestations typically are very spotty, usually occurring near weedy patches or along field borders. Consider spot treating infested sites rather than the entire field.

Management—biological control

- ◆ *Bacillus thuringiensis aizawai* (XenTari – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. REI 4 hr. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP, Deliver, Dipel DF, Javelin WG, and others – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. REI 4 hr. Biological insecticide most effective against small, newly hatched larvae of climbing cutworms. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ GS-omega/kappa-Hctx-Hv1a (Spear LEP – peptide derived from spider venom)—See label for rates. Tank mix with *Bacillus thuringiensis* products (Bts) to enhance control. PHI 0 days

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC, Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. For Fastac CS, do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Azatin XL) at 0.01 to 0.02 lb ai/a. Foliar application against larvae.
 - (Aza-Direct) at 0.0123 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy pest infestation.
 - (Debug Trés) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7-10 days.
- ◆ azadirachtin/pyrethrins (Azera and Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ carbaryl (Carbaryl 4L, Sevin 4F, Sevin 5 Bait, Sevin XLR Plus, Sevin 80 Solupak, Bran For Grasshoppers, and others) at 0.6 to 1.5 lb ai/a. PHI 28 days. For Carbaryl 4L, Sevin 4F, Sevin 5 Bait, and Sevin XLR Plus, do not apply more than a total of 3 lb ai/a per crop. For Sevin 80 Solupak, do not apply more than 4 lb ai/a per crop. For Bran for Grasshoppers, do not apply more than 1.2 lbs ai/a per crop.

- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others)
 - Preplant or at planting—Apply at 0.5 lb ai/a incorporated in 10-inch band over row. PHI 30 days. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Lorsban Advanced, Vulcan) at 0.939 lb ai/a broadcast application.
 - Preplant or at planting—Apply at 0.469 lb ai/a incorporated in 10-inch band over row. PHI 30 days. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Lorsban 15G, Lorsban 15G Smartbox, Pilot 15G, Saurus)—Apply at 1.5 to 2 lb ai/a in 4- to 5- inch band at planting. REI 24 hr. Do not apply granules in direct contact with seeds. Do not apply more than once per year. Incorporate into the top 0.5 to 1 inch of soil.
- ◆ chlorpyrifos (Chlorpyrifos 4E, Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) Postemergence—Apply at 1 lb ai/a broadcast, or at 0.67 lb ai/a in a 5- to 7-inch band. PHI 30 days. Do not allow livestock to graze in treated areas or use harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Lorsban Advanced, Vulcan) at 0.625 lb ai/a band application. Apply as 5- to 7-inch band, lightly incorporate mechanically or with irrigation.
 - Postemergence—Apply at 0.939 lb ai/a broadcast, or at 0.626 lb ai/a in a 5- to 7-inch band. PHI 30 days. Do not allow livestock to graze in treated areas or use harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.118 to 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ clothianidin (NipsIt INSIDE)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a as seedling spray. PHI 21 days. Apply as necessary, but do not apply more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) to coverage uniformly.
- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.45 lb ai/a for variegated cutworm. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop or apply more than 10 times per crop.
- ◆ methoxyfenozide (Inspirato 2F, Intrepid 2F, Invertid 2F, Troubadour, Withstand, Zyllo) at 0.12 to 0.25 lb ai/a. For suppression only. Apply at egg hatch or when signs of feeding occur. PHI 7 days.
- ◆ methoxyfenozide/spinetoram (Intrepid Edge) at 0.11 to 0.28 lb ai/a. For suppression only. Apply at egg hatch or first signs of feeding. PHI 7 days.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins and piperonyl butoxide (Pyrenone, Pyronyl Crop Spray)—See label for rates.
- ◆ spinosad (Seduce) at 0.014 to 0.031 lb ai/a. Soil-applied insecticidal bait that attracts and kills insects; use standard broadcast spreader for broadcast application or standard granular spreader for row application. Do not apply more than four times per crop (more than 0.33 lb ai/a per crop) or less than seven days apart or more than three times in any 30-day period. PHI 3 days. Some formulations are OMRI-listed for organic use.
- ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter 20G Smartbox, Counter 15G Lock'n Load, Counter 15G Smartbox) at 1.2 oz ai/1,000 row feet—for suppression only. Apply at planting in a 5- to 7-inch band over the row and lightly incorporate. Do not allow granules to contact seed. Only one application per year. Do not exceed 2 lb ai/a. PHI 150 days.
- ◆ zeta-cypermethrin—
 - (Mustang) PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications).
 - * At planting application—Apply at 0.05 lb ai/a on soil surface in a 5- to 7-inch band, or broadcast in at least 3 to 5 gal/a water.
 - * Foliar application—Apply at 0.028 to 0.05 lb ai/a with equipment for ground or air application, using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.
 - * At planting—Apply at 0.025 lb/ai/a. Apply on the soil surface in a 5- to 7-inch band or broadcast in a minimum of 3 to 5 gal per acre.

Sugar beet—Flea beetle (adult)

Includes

Pale striped flea beetle (*Systema elongate*)
 Three-spotted flea beetle (*Disconycha triangularis*)
 Tuber flea beetle (*Eptitrix tuberis*)
 Western potato flea beetle (*E. subcristata*)

Pest description and crop damage Pinhead-sized, metallic green-black jumping beetles chew small “shotholes” in cotyledons and first true leaves of seedling sugar beets, especially plants along ditchbanks and fencerows where beetles overwinter. Damage is most severe when abnormally cool spring weather retards sugar beet plant growth.

Scouting and thresholds No formal economic thresholds exist for flea beetle insecticide treatment decisions.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard ES, Mycotrol ESO, Mycotrol O—live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray for signs of effectiveness. Begin treatment at first appearance of pest. Reapply as necessary. Some formulations are OMRI-listed for organic use.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC, Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. For Fastac CS, do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.

- (Azatin XL) at 0.01 to 0.033 lb ai/a.
- (Debug Très) at 0.0375 to 0.1054 lb ai/a
- (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7 to 10 days.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ carbaryl (Carbaryl 4L, Sevin 4F, Sevin XLR Plus, Sevin 80 Solupak, and others) at 1 to 1.5 lb ai/a. PHI 28 days. For Carbaryl 4L, Sevin 4F, and Sevin XLR Plus, do not apply more than a total of 3 lb ai/a per crop. For Sevin 80 Solupak, do not apply more than 4 lb ai/a per crop.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 1 lb ai/a broadcast application –or– Lorsban Advanced, Vulcan at 0.939 lb ai/a broadcast application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.67 lb ai/a band application –or– Lorsban Advanced, Vulcan at 0.625 lb ai/a band application. Apply as 5- to 7-inch band, lightly incorporate mechanically or with irrigation.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.118 to 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ clothianidin (NipsIt INSIDE)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/beta cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Do not apply more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) to cover uniformly.
- ◆ kaolin (Surround CF and Surround WP) at 5.94 to 11.88 lb ai/a for Surround CF and 23.75 to 47.5 lb ai/a for Surround WP. For suppression only. Product forms a barrier film that acts as a protectant; apply before infestations develop and continue on a 7 to 14 day schedule for the duration of the infestation. Surround WP is OMRI-listed for organic use.
- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.225 to 0.9 lb ai/a. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop. Do not apply more than 10 times per crop.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, and Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.

- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ spinosad (Radiant SC) at 0.05 to 0.0625 lb ai/a. For suppression only. Do not apply more than 0.25 lb ai/a per crop. PHI 7 days. Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Garden symphylan

Scutigera immaculata

Pest description and crop damage Active, white, fragile, centipede-like, soil-borne relatives of insects, 0.25 inch long, with 12 or more pairs of legs. They primarily damage sugar beets early in the season by feeding on germinating seed or on small roots of seedling plants.

Scouting and thresholds No formal **economic thresholds** exist for symphylan insecticide treatment decisions. They occur in unpredictably spotty infestations and generally are considered minor pests. There are no effective “rescue” treatments that can be applied postemergence in sugar beets for symphylans.

Management—chemical control

- ◆ 1,3-dichloropropene (Telone II) and 1,3-dichloropropene/chloropicrin (Telone C-17, Telone C-35)—Preplant soil fumigants.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.

See also:

Biology and Control of the Garden Symphylan

Sugar beet—Grasshopper

Includes

Migratory grasshopper (*Melanoplus sanguinipes*)
Red-legged grasshopper (*Melanoplus femurrubrum*)

Pest description and crop damage Infestations are most likely where sugar beet fields immediately adjoin grasshopper breeding sites in uncultivated grassy rangelands and desert areas. Grasshoppers are problems especially when rangeland vegetation dries earlier than normal and they move to still-green field crops.

Scouting and thresholds No formal **economic thresholds** exist for grasshopper insecticide treatment decisions. Consider treating field edges where grasshoppers are advancing rather than entire fields.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard 22WP, BotaniGard ES, Mycotrol ESO, Mycotrol O – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary. OMRI-listed for organic use.

Management—chemical control

- ◆ alpha-cypermethrin (Fastac EC, Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gal per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. For Fastac CS do not graze or harvest sugar beet tops for livestock feed.
- ◆ azadirachtin (Debug Trés) at 0.0375 to 0.1054 lb ai/a.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. Some formulations are OMRI-listed for organic use.
- ◆ carbaryl (Carbaryl 5% Bait, Carbaryl Cutworm Bait, Sevin 5 Bait, and Bran For Grasshoppers) at 0.6 to 1.5 lb ai/a. PHI 28 days. Do not apply more than 3 lb ai/a per crop; for Bran for Grasshoppers, do not apply more than 1.2 lbs ai/a per crop.
- ◆ chlorpyrifos (Chlorpyrifos 4E, Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.25 to 0.5 lb ai/a broadcast OR Lorsban Advanced, Vulcan at 0.235 to 0.469 lb ai/a broadcast application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Apply as necessary, but no more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water to cover uniformly (at least 2 gal/a of water).
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ kaolin (Surround WP) at 23.75 to 47.5 lb ai/a. For suppression only. Product forms a barrier film that acts as a protectant; apply before infestations develop and continue on a 7- to 14-day schedule for the duration of the infestation. OMRI-listed for organic use.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. REI 48 hr. PHI 2 days. Recommendation as permitted under FIFRA Section 2(ee). Do not apply more than 4.7 lb ai/a per season.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus) See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD) See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.

◆ zeta-cypermethrin—

- (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
- (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal/a by air and 10 gal/a by ground.

Sugar beet—Leafminer

Beet leafminer (*Pegomya betae*)

Spinach leafminer (*Pegomya hyoscyami*)

Pest description and crop damage Legless maggots, 0.5 inch long when mature, feed between the upper and lower leaf surfaces, leaving irregular transparent windows, blotches, and winding tunnels. Historically a common pest that rarely reached economically damaging levels, it is now an increasingly important pest in some local areas. Damage is of more concern early in the season during stand establishment; older plants should be able to tolerate more leafminer damage.

Scouting and thresholds No formal economic thresholds exist for leafminer insecticide treatment decisions.

Management—biological control

Larvae often are highly parasitized. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications.

Management—chemical control

- ◆ aldicarb (AgLogic 15G, AgLogic 15GG) at 2.1 to 3 lb ai/a. PHI 90 days, 120 days if tops are fed to livestock. Do not use tops as food for humans. Do not make more than one at-planting and two postemergence applications per crop. Do not exceed a total of 4.95 lb ai/a per season. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil.
 - At planting (or within 1 week prior)—Drill granules 1 to 3 inches below seedline. Granules can be placed into the seed furrow if rate does not exceed 1.05 lb ai/a.
 - Postemergence—Apply granules to both sides of plant row and immediately work into the soil or cover with soil, or, for furrow irrigation, side-dress granules 4 to 8 inches to water furrow side of plant row and at furrow depth. Irrigate soon after application. Apply within 60 days after planting. Do not make any postemergence applications if 4.05 to 4.95 lb ai/a was applied at planting or within 1 week prior to planting.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Aza-Direct) at 0.0123 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy infestation.
 - (Debug Trés) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray when pests first appear and repeat after 7-10 days.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Yuma 4E, and others) at 0.5 lb ai/a broadcast application –or– Lorsban Advanced, Vulcan at 0.469 lb ai/a broadcast application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.335 lb ai/a band application –or– Lorsban Advanced, Vulcan at 0.313 lb ai/a band application. Apply as 5- to 7-inch band, lightly incorporated mechanically or with irrigation.

- ◆ clothianidin (NipsIt INSIDE)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ mineral oil (470 Supreme Spray Oil, BioCover, JMS Stylet Oil, SunSpray, and others)—See label for rates. Some formulations are OMRI-listed for organic use.
- ◆ phorate—(Thimet 20G and others)—Apply *at planting* 0.68 to 0.9 oz ai/1,000 row ft. PHI 30 days. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Drill to side of seed or band over seed. No more than one application per cropping season.
- ◆ potassium salts of fatty acids (M-Pede)—See label for rates. Apply only in tank mix with labeled companion insecticide; see label about tank mixing. PHI 0 days.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins and piperonyl butoxide (Pyronyl Crop Spray and Pyrenone)—See label for rates.
- ◆ spinosad
 - (Blackhawk) at 0.051 to 0.079 lb ai/a. Do not apply fewer than 7 days apart. Do not apply more than 0.33 lb ai per crop. PHI 3 days.
 - (Entrust, Entrust SC) at 0.07 to 0.16 lb ai/a. Do not apply fewer than 7 days apart. Do not apply more than four times per crop or apply more than 0.33 lb ai/a per crop. PHI 3 days. OMRI-listed for organic use.
 - (Radiant SC) at 0.05 to 0.0625 lb ai/a. For suppression only. Do not apply more than 0.25 lb ai/a per crop. PHI 7 days.
 - (Success) at 0.025 to 0.05 lb ai/a. Do not apply more than four times per crop or apply more than 0.45 lb ai/a per crop. PHI 3 days. Use of a penetrating surfactant oil is critical for optimal control of leafminers.
- ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Adult control only. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Adult control only. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Looper

Alfalfa looper (*Autographa californica*)
Cabbage looper (*Trichoplusia ni*)

Pest description and crop damage This is a minor leaf-feeding pest of sugar beets, most commonly seen late in the season in sugar beets that border alfalfa fields. Mature larvae are up to 1.5 inches long and light to dark green with a thin white stripe along each side. Loopers differ from all other sugar beet caterpillars in that they have only three pairs of fleshy prolegs—on abdominal segments 5,

6, and 10—and crawl in a characteristic looping motion; all other sugar beet caterpillars have five pairs of prolegs—on abdominal segments 3, 4, 5, 6, and 10.

Scouting and thresholds No formal **economic thresholds** exist for looper insecticide treatment decisions in sugar beets.

Management—biological control

- ◆ *Bacillus thuringiensis aizawai* (Agree WG, XenTari – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP, Crymax, Deliver, Dipel DF, Javelin WG, and others – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. REI 4 hr. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana* (BotaniGard ES, Mycotrol ESO, Mycotrol O – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary. OMRI-listed for organic use.
- ◆ *Chromobacterium subsugae* (Grandevo, Grandevo PTO, Grandevo WDG – insect-killing bacterium) at 0.3 to 0.9 lb ai/a. REI 4 hr. Must be mixed with water and applied as a foliar spray with ground or aerial equipment for conventional spraying or by chemigation. Some formulations are OMRI-listed for organic use.
- ◆ GS-omega/kappa-Hctx-Hv1a (Spear LEP – peptide derived from spider venom)—See label for rates. Tank mix with *Bacillus thuringiensis* products (Bts) to enhance control. PHI 0 days

Management—chemical control

- ◆ alpha-cypermethrin (Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. Do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Azatin XL) at 0.01 to 0.02 lb ai/a. Foliar application against larvae.
 - (Aza-Direct) at 0.01234 to 0.024 lb ai/a and up to 0.0432 lb ai/a under extremely heavy pest infestation.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray nymphs early and repeat application after 7 days.
- ◆ azadirachtin/pyrethrins (Azera and Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ *Burkholderia* spp. (Venerate XC – heat-killed insecticidal bacteria)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Apply as necessary but no more than 0.15 lb

ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) to cover uniformly.

- ◆ methoxyfenozide (Inspirato 2F, Intrepid 2F, Invertid 2F, Troubadour, Withstand, Zylor) at 0.12 to 0.25 ai/a. Apply at egg hatch or when signs of feeding occur. PHI 7 days.
- ◆ methoxyfenozide and spinetoram (Intrepid Edge) at 0.11 to 0.28 lb ai/a. Apply at egg hatch or first signs of feeding. PHI 7 days.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ sodium tetraborohydrate decahydrate (Prev-AM Ultra) applied as a 0.4% solution for cabbage looper, 40-50 gal per acre. Spray every 7 to 10 days as necessary.
- ◆ spinosad—
 - (Blackhawk) at 0.051 to 0.079 lb ai/a. Do not apply fewer than 7 days apart. Do not apply more than 0.33 lb ai per crop. PHI 3 days.
 - (Entrust, Entrust SC) at 0.075 to 0.15 lb ai/a. Do not apply less than 7 days apart. Do not apply more than four times per crop or apply more than 0.33 lb ai/a per crop. PHI 3 days. OMRI-listed for organic use.
 - (Radiant SC) at 0.05 to 0.0625 lb ai/a. Do not apply more than 0.25 lb ai/a per crop. PHI 7 days.
 - (Success) at 0.025 to 0.05 lb ai/a. Do not apply more than four times per crop or apply more than 0.45 lb ai/a per crop. PHI 3 days.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Lygus bug

Lygus spp.

Pest description and crop damage Pale green to red-brown sap-sucking bugs, 0.25 inch long when mature; the wings of adults fold flat over the back producing a light-color, V-shaped mark behind the thorax. Lygus bugs are primarily seed feeders, so usually they are inconsequential pests except in sugar beet seed fields.

Scouting and thresholds No formal economic thresholds exist for lygus bug insecticide treatment decisions in sugar beets.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard ES, Mycotrol ESO, Mycotrol O – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary.

Management—chemical control

- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Aza-Direct) at 0.0123 to 0.0247 lb ai/a and up to 0.0432 lb ai/a under extremely heavy pest infestation.
 - (Debug Trés) at 0.0375 to 0.1054 lb ai/a
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray nymphs early and repeat application after 7 days.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.5 lb ai/a broadcast postemergence –or– Lorsban Advanced, Vulcan at 0.469 lb ai/a broadcast application postemergence. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment. Do not apply more than 3 lb ai/a or more than three times per season.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ kaolin (Surround CF) at 5.94 to 11.88 lb ai/a. For suppression only. Product forms a barrier film that acts as a protectant; apply before infestations develop and continue on a 7 to 14 day schedule for the duration of the infestation.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. PHI 2 days. REI 48 hr. Recommendation as permitted under FIFRA Section 2(ee). Do not apply more than 4.7 lb ai/a per season.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Saltmarsh caterpillar

Estigmene acrea

Pest description and crop damage “Woolly bear” caterpillars up to 2 inches long, covered by long, red-brown hairs. They are seen especially in late season but rarely are an economic problem.

Scouting and thresholds No formal economic thresholds exist for saltmarsh caterpillar insecticide treatment decisions.

Management—biological control

- ◆ *Bacillus thuringiensis aizawai* (XenTari – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. Biological insecticide most effective against newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. REI 4 hr. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP, Crymax, Deliver, Dipel DF, Javelin WG, and others – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. REI 4 hr. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ GS-omega/kappa-Hctx-Hv1a (Spear LEP – peptide derived from spider venom)—See label for rates. Tank mix with *Bacillus thuringiensis* products (Bts) to enhance control. PHI 0 days

Management—chemical control

- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ esfenvalerate, (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Apply as necessary but not more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) to cover uniformly.
- ◆ methoxyfenozide (Inspirato 2F, Intrepid 2F, Invertid 2F, Troubadour, Withstand, Zyllo) at 0.12 to 0.25 lb ai/a. Apply at egg hatch or when signs of feeding occur. PHI 7 days.
- ◆ methoxyfenozide and spinetoram (Intrepid Edge) at 0.11 to 0.28 lb ai/a. Apply at egg hatch or first signs of feeding. PHI 7 days.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.

Sugar beet—Spider mite

Tetranychus spp.

Pest description and crop damage These are a sporadic problem, generally in western Idaho. Spider mite outbreaks are associated with:

1. Dusty sites; infestations especially begin along field edges adjoining dusty roads and in surface-irrigated fields.
2. Excessive use of foliar-applied insecticides (especially pyrethroids and organophosphates) directed at aphid or pests other than spider mites, but which also kill mite natural enemies and so allow spider mites to increase without checks.
3. Hot, dry weather that enhances mite survival and reproduction; short generation times and multiple generations allow explosive increases in spider mite infestation levels.
4. Weedy fence rows and ditch banks where mites overwinter.

Scouting and thresholds No formal economic thresholds exist for spider mite insecticide treatment decisions.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard ES, Mycotrol ESO – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary. OMRI-listed for organic use.

Management—chemical control

- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Aza-Direct) at 0.0123 to 0.0247 lb ai/a and up to 0.0432 lb ai/a under extremely heavy pest infestation.
 - (Debug Trés) at 0.0375 to 0.1054 lb ai/a.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days.
- ◆ canola oil/garlic oil/capsicum oleoresin extract (Captive Prime)—See label for rates. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.5 lb ai/a broadcast application –or– Lorsban Advanced, Vulcan at 0.469 lb ai/a broadcast application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.33 lb ai/a band application –or– Lorsban Advanced, Vulcan at 0.313 lb ai/a band application. Apply as 5- to 7-inch band, lightly incorporated mechanically or with irrigation.
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ hexythiazox (Onager and Ruger 1EC) at 0.094 to 0.188 lb ai/a. PHI 45 days. Do not make more than one application per calendar year.
- ◆ kaolin (Surround CF) at 5.94 to 11.88 lb ai/a. For suppression only. Product forms a barrier film that acts as a protectant; apply before infestations develop and continue on a 7- to 14-day schedule for the duration of the infestation.
- ◆ mineral oil (470 Supreme Spray Oil, BioCover, JMS Stylet Oil, SunSpray, and others)—See label for rates. Some formulations are OMRI-listed for organic use.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. REI 48 hr. PHI 2 days. Do not apply more than 4.7 lb ai/a per season.
- ◆ neem oil (NimBioSys, Terraneem EC, and others)—See label for rates. OMRI-listed for organic use.
- ◆ oxydemeton-methyl (MSR Spray Concentrate) at 0.45 to 0.6 lb ai/a. PHI 30 days. Do not apply more than once per season. Do not harvest beets or use beet tops for feed or forage within 30 days of last application.
- ◆ phorate (Thimet 20G and others)
 - *At planting*—Apply at 0.68 to 0.9 oz ai/1,000 row ft. PHI 30 days. Drill to side of seed or band over seed. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Only one application per cropping season.
 - *Postemergence*—Apply at 0.975 to 1.5 lb ai/a. PHI 30 days. Apply to foliage when plants are dry. Only one postemergence treatment per season. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Only one application per cropping season.

- ◆ potassium salts of fatty acids (Des-X, Kopa, and M-Pede)—See label for rates. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ potassium silicate (Sil-Matrix) at 1.5 to 3 lb ai/a. For suppression only. Do not apply more than 21 lb ai/a per season. PHI 0 days. OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, and Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ soybean oil/garlic oil/capsicum oleoresin extract (Captiva)—See label for rates. PHI 0 days. REI 4 hr.
- ◆ sulfur (too many commercial products to list all trade names here)—PHI 0 days. Rates depend on formulation. Some formulations are OMRI-listed for organic use.

Sugar beet—Stink bug

Pentatomidae

Pest description and crop damage Stink bugs are primarily seed feeders, so they are usually inconsequential pests except in sugar beet seed fields.

Scouting and thresholds No formal action thresholds exist for stink bug insecticide treatment decisions.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard ES, Mycotrol ESO, Mycotrol O – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary.

Management—chemical control

- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Aza-Direct) at 0.0123 to 0.0247 lb ai/a and—under extremely heavy pest infestation—up to 0.0432 lb ai/a.
 - (Ecozin Plus) at 0.012 to 0.023 lb ai/acre. Spray nymphs early and repeat application after 7 days.
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, and Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.

Sugar beet—Sugar beet crown borer

Hulstia undulatella

Pest description and crop damage Caterpillar is a dirty brown color with a green tint. Larvae feed on petioles at the plant crown and along the side of the taproot. They remain by day just below the soil surface within soil-coated silken tubes that extend 2 to 6 inches from infested plants. They are most damaging as first generation larvae during May.

Management—chemical control

- ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter 20G Smartbox, Counter 15G Lock'n Load, Counter 15G Smartbox)—One application per year. Do not place in direct contact with seed. Do not exceed 2 lb ai/a. PHI 110 days for at planting banded, at planting in-furrow, or postemergence applications.
 - At planting—Apply at 0.6 to 1.2 oz ai/1,000 row ft banded or modified in-furrow. Apply in 5- to 7-inch band over the row and lightly incorporate or apply in furrow 2 to 3 inches behind seed drop zone after some soil has covered the seed. Use 1.2 oz ai/1,000 row ft rate if especially heavy infestations are expected.
 - Postemergence—Apply at 0.6 to 1.2 oz ai/1,000 row ft banded. Apply in 5- to 7-inch band over the row; lightly incorporate. Apply at first sign of infestation.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Note: See University of Idaho publication CIS 845, *The Sugar Beet Crown Borer in Idaho*, for more details.

Sugar beet—Sugar beet root aphid

Includes

Pemphigus betae
Pemphigus populivinae

Pest description and crop damage Pinhead-sized, pale white-yellow aphid that colonizes taproot. They are covered with waxy white secretions that superficially resemble mold.

Scouting and thresholds No formal economic thresholds exist for root aphid insecticide treatment decisions. Root aphids typically infest fields during late summer, which makes “rescue” treatments using registered insecticides impossible.

Management—cultural control

Root aphids can be managed by planting approved resistant varieties. Maintaining a proper irrigation schedule can help plants to resist attack from root aphids; aphids are favored by drier soils and drought-stressed plants.

Management—biological control

Root aphids are attacked by a predatory fly that generally keeps infestations in check. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications.

Management—chemical control

- ◆ imidacloprid (Agrisolutions Nitro Shield, Agristar Macho 600 ST, Attendant 480 FS, Access Insecticide Seed Treatment, Dyna-Shield Imidacloprid 5, Gaucho 480 Flowable, Gaucho 600 Flowable, Senator 600FS, Sharda 5SC, and others)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ spirotetramat (Movento and Movento HL) at 0.07 to 0.14 lb ai/a. PHI 28 days. Do not exceed 0.28 lb ai/a per crop season.
- ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter 20G Smartbox, Counter 15G Lock'n Load, Counter 15G Smartbox)—Apply postemergence at 0.6 to 1.2 oz ai/1,000 row feet. One application per year. Do not place in direct contact with seed. Apply in 5- to 7-inch band over the row and lightly incorporate. PHI 110 days.
- ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.

Note: See University of Idaho publication CIS 1176, Sugar Beet Root Aphids: Identification, Biology, & Management for more details.

Sugar beet—Sugar beet root maggot

Tetanops myopaeformis

Pest description and crop damage Widespread in Idaho and the adjoining Oregon production region, they annually reach economically damaging levels. Spring-emerging adult flies lay eggs in soil next to young sugar beet plants during May and June. Soil-borne larvae subsequently feed on the taproot through mid-July, then diapause as non-feeding, overwintering larvae.

Scouting and thresholds

For larval control

1. Use field history to determine the need for at-planting insecticides.
2. Determine the timing of postemergence insecticide applications by monitoring local flight activity of adult root maggots with orange-colored sticky traps. Control is most effective when insecticide application coincides with the time of peak seasonal fly capture on traps; earlier and especially later application is less effective. Total seasonal captures of 40 to 50 flies per trap through peak collection justify postemergence treatments. See University of Idaho publication CIS 999, *IPM Guide to Sugar Beet Root Maggot*, <http://www.uidaho.edu/sugarbeet/insc/sbmaggot.htm>

For adult control

Adult root maggot flies are highly mobile; they continually colonize fields over long distances during a 6-week egg-laying period. Control requires repeated insecticide applications to kill flies before they lay eggs, but this has the potential negative side effects of selecting for pesticide resistant strains and triggering outbreaks of aphid and leaf-feeding caterpillars by eliminating their natural enemies.

Management—chemical control

Larval control

- ◆ aldicarb (AgLogic 15G, AgLogic 15GG) at 1.05 to 2.1 lb ai/a. PHI 90 days, 120 days if tops are fed to livestock. Do not use tops as food for humans. Do not make more than one at-planting and two postemergence applications per crop. Do not exceed a total of 4.95 lb ai/a per season. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil.
 - *At planting* (or within 1 week prior)—Drill granules 1 to 3 inches below seedline. Granules can be placed into the seed furrow if rate does not exceed 1.05 lb ai/a.
 - *Postemergence*—Apply granules to both sides of plant row and immediately work into the soil or cover with soil, or, for

furrow irrigation side-dress granules 4 to 8 inches to water-furrow side of plant row and at furrow depth. Irrigate soon after application. Apply within 60 days after planting. Do not make any postemergence applications if 4.05 to 4.95 lb ai/a was applied at planting or within 1 week prior to planting.

- ◆ chlorpyrifos (Lorsban 15G, Lorsban 15G Smartbox, Pilot 15G, Saurus)—
 - *At planting*—Apply at 1 to 2 lb ai/a based on 22-inch row spacing. REI 24 hr. Apply in 4- to 5-inch band behind planter shoe, over drill row, and in front of press wheel; do not apply granules in direct contact with seeds. Incorporate into top 0.5 to 1 inch of soil. If heavy fly pressure is expected, you can augment at planting applications with chlorpyrifos 4E postemergence.
 - *Postemergence*—Apply at 1.5 to 2 lb ai/a based on 22-inch row spacing. Apply granules in 3- to 5-inch band over row (up to two- to four-leaf stage). Incorporate into the top 0.5 to 1 inch of soil. Do not apply more than once per year.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Vulcan, Warhawk, Whirlwind, Yuma 4E, and others)—
 - *Postemergence* (primary treatment)—Apply at 0.67 to 1 lb ai/a band application. Apply spray in 5- to 7-inch band over row, lightly incorporate mechanically or with irrigation. Base application timing on local monitoring of fly activity with traps. Apply from 7 days before until 3 days after peak adult emergence. Do not apply more than 2 lb ai/a of the 75WG formulation per season or more than 3 lb ai/a of the 4E formulation per season. Do not apply more than three times per season.
- ◆ chlorpyrifos (Lorsban Advanced)—
 - *Postemergence* (primary treatment)—Apply at 0.626 to 0.939 lb ai/a band application. Apply spray in 5- to 7-inch band over row, lightly incorporate mechanically or with irrigation. Base application timing on local monitoring of fly activity with traps. Apply from 7 days before until 3 days after peak adult emergence. Do not apply more than 2 lb ai/a of the 75WG formulation per season or more than 3 lb ai/a of the 4E formulation per season. Do not apply more than three times per season.
- ◆ clothianidin (NipsIt INSIDE)—Application only by commercial seed treaters; no on-farm seed treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo)—Application only by commercial seed treaters; no on-farm seed-treatment.
- ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed treatment application.
- ◆ phorate—
 - *At planting* (Thimet 20G and others)—Apply at 0.68 to 0.9 oz ai/1,000 row ft. PHI 30 days. Do not feed tops or silage to dairy cattle. Do not place granules in direct contact with seed. Drill to side of seed or band over seed. No more than one application per cropping season.
 - *Postemergence* (Thimet 20G and others)—Apply at 0.98 to 1.5 lb ai/a to foliage when plants are dry. Only one treatment postemergence per season. Do not feed tops or silage to dairy cattle. No more than one application per cropping season.
- ◆ spirotetramat (Movento and Movento HL) at 0.07 to 0.14 lb ai/a. PHI 28 days. Do not exceed 0.28 lb ai/a per crop season.
- ◆ terbufos (Counter CR Lock'n Load, Counter 20G Lock'n Load, Counter 20G Smartbox, Counter 15G Lock'n Load, Counter 15G Smartbox)—One application per year. Do not place in direct contact with seed. Do not exceed 2 lb ai/a. PHI 110 days.
 - *At planting*—Apply at 0.6 to 1.2 oz ai/1,000 row ft banded or modified in-furrow. Apply in 5- to 7-inch band over the row

and incorporate or apply in furrow, 2 to 3 inches behind seed drop zone after some soil has covered the seed.

- *Postemergence*—Apply at 0.6 to 1.2 oz ai/1,000 row ft banded. Apply in 5- to 7-inch band over the row; lightly incorporate. Apply at first sign of fly emergence.
- ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ zeta-cypermethrin—
 - (Mustang) at-planting application **for suppression only** of light to moderate infestations at 0.05 lb ai/a. Apply in furrow or in a 3- to 4-inch T-Band (band over open furrow) in a minimum of 3 to 5 gal/a water. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications).
 - (Mustang Maxx) at planting, 0.025 lb ai/a. Suppression only. For light to moderate infestations only. Make a 3 to 4 inch T-Band at planting in a minimum of 3 to 5 gal per acre. 50 day PHI for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr.

Adult (fly) control

- ◆ alpha-cypermethrin (Fastac CS) at 0.014 to 0.025 lb ai/a. PHI 50 days. REI 12 hr. Apply by air or ground equipment using sufficient water to obtain full coverage of foliage (minimum of 2 gallons per acre by air and 10 gal per acre by ground). Apply no more than 0.075 lb ai/a per season. Do not graze or harvest treated sugar beet tops for livestock feed.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.25 to 0.5 lb ai/a broadcast—or— Lorsban Advanced, Vulcan at 0.235 to 0.469 lb ai/a broadcast. PHI 30 days. Apply anytime from 7-days before until 3-days after peak adult emergence in order to target adult flies present at time of application based on local field monitoring. Reduce potential for development of insecticide resistance by (1) avoid making more than two applications of chlorpyrifos 4E per season when adults are active or (2) do not make more than 1 post-emergence application of chlorpyrifos 4E when adults are active if an organophosphate insecticide was applied at planting. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.278 lb ai/a as post emergence broadcast or banded foliar spray for suppression only. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Apply during peak adult emergence. Reduce potential for development of insecticide resistance by (1) not making more than two applications of Stallion Brand per season when adults are active or (2) not making more than one post-emergence application of Stallion Brand when adults are active if an organophosphate insecticide (i.e., chlorpyrifos, phorate, or terbufos) was applied at planting. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ esfenvalerate (Asana XL and S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Do not apply more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) for uniform coverage.
- ◆ naled (Dibrom 8 Emulsive) at 0.94 lb ai/a. PHI 2 days. REI 48 hr. Recommendation as permitted under FIFRA Section 2(ee). Do not apply more than 4.7 lb ai/a per season.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment using enough water to fully cover foliage.

- (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—Webworm

Beet webworm (*Loxostege sticticalis*)

Garden webworm (*Achyra rantalis*)

Pest description and crop damage Olive-green larvae up to 1.5 inches long, marked with black dots and both dark and light stripes down the back and along sides. If disturbed, larvae hang from leaves by silk threads.

Feeding initially appears as small transparent “windows” eaten from the undersides of leaves; later, it progresses to raggedly skeletonized and dirty, webbed leaves, especially midseason.

Scouting and thresholds No formal economic thresholds exist for webworm insecticide treatment decisions. Consider treatment if infestation levels average one to two webworm larvae on half the plants. Monitor infestations closely, because webworms can defoliate plants rapidly.

Management—biological control

- ◆ *Beauveria bassiana* (live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary.
- ◆ *Bacillus thuringiensis aizawai* (XenTari – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis kurstaki* (Biobit HP, Dipel DF, Javelin, and others – live spores of an insect-killing bacterium)—See label for rates. PHI 0 days. REI 4 hr. Biological insecticide most effective against small, newly hatched larvae. No contact action; larvae must eat treated leaves. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ GS-omega/kappa-Hctx-Hv1a (Spear LEP – peptide derived from spider venom)—See label for rates. Tank mix with *Bacillus thuringiensis* products (Bts) to enhance control. PHI 0 days

Management—chemical control

- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a.
- ◆ azadirachtin/pyrethrins (Azera and Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ carbaryl (Carbaryl 4L, Sevin 4F, Sevin XLR Plus, Sevin 80 Solupak, and others) at 1 to 1.5 lb ai/a. PHI 28 days. For Carbaryl 4L, Sevin 4F, and Sevin XLR Plus, do not apply more than a total of 3 lb ai/a per crop. For Sevin 80 Solupak, do not apply more than 4 lb ai/a per crop.
- ◆ chlorpyrifos (Eraser, Govern 4E, Lorsban 4E, Lorsban 75WG, Nufos 4E, Pilot 4E, Warhawk, Whirlwind, Yuma 4E, and others) at 0.5 to 1 lb ai/a broadcast, or 0.335 to 0.67 lb ai/a band application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment. Apply band application as 5- to 7-inch spray; lightly incorporate mechanically or with irrigation. Do not apply more than 2 lb ai/a of the 75WG formulation per season or more

than 3 lb ai/a of the 4E formulation per season. Do not apply chlorpyrifos more than three times per season.

- ◆ chlorpyrifos (Lorsban Advanced, Vulcan) at 0.469 to 0.939 lb ai/a broadcast, or 0.313 to 0.626 lb ai/a band application. PHI 30 days. Do not let livestock graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 30 days after last treatment. Apply band application as 5- to 7-inch spray; lightly incorporate mechanically or with irrigation. Do not apply more than 2 lb ai/a of the 75WG formulation per season or more than 3 lb ai/a of the 4E formulation per season. Do not apply chlorpyrifos more than three times per season.
- ◆ chlorpyrifos/zeta-cypermethrin (Stallion Brand) at 0.118 to 0.278 lb ai/a as post emergence broadcast or banded foliar spray. Do not apply as an in-furrow treatment. PHI 50 days. REI 24 hr. Do not allow livestock to graze in treated areas or harvest treated beet tops as feed for meat or dairy animals within 50 days after last treatment.
- ◆ esfenvalerate (Asana XL, S-fenvaloStar, Zyrate) at 0.03 to 0.05 lb ai/a. PHI 21 days. Apply as necessary but no more than 0.15 lb ai/a per season. Apply with ground or air equipment using enough water (at least 2 gal/a) to cover uniformly.
- ◆ methomyl (Annihilate LV, Annihilate SP, Corrida 29 SL, Corrida 90 WSP, Lannate LV, Lannate SP, M1 LV, M1 SP, Nudrin LV, Nudrin SP) at 0.225 to 0.9 lb ai/a. PHI for roots 21 days or 30 days if tops are fed to livestock. REI 48 hr. Do not apply more than 4.5 lb ai/a per crop or apply more than 10 times per crop.
- ◆ methoxyfenozide (Inspirato 2F, Intrepid 2F, Invertid 2F, Troubadour, Withstand, Zylo) at 0.12 to 0.25 lb ai/a. Apply at egg hatch or when signs of feeding occur. PHI 7 days.
- ◆ methoxyfenozide/spinetoram (Intrepid Edge) at 0.11 to 0.28 lb ai/a. Apply at egg hatch or first signs of feeding. PHI 7 days.
- ◆ neem oil (Terraneem EC)—See label for rates. OMRI-listed for organic use.
- ◆ pyrethrins (Lynx EC 1.4, Lynx EC 5.0, PyGanic EC 1.4, Tersus)—See label for rates. REI 12 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ pyrethrins and piperonyl butoxide (Evergreen Crop Protection EC 60-6, Pyrenone, Pyronyl Crop Spray, and others)—See label for rates.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.028 to 0.05 lb ai/a. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications). Apply with ground or air equipment with enough water to fully cover foliage.
 - (Mustang Maxx) at 0.014 to 0.025 lb ai/a. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr. Apply by air or ground using minimum of 2 gal per acre by air and 10 gal per acre by ground.

Sugar beet—White grub

Scarabaeidae

Pest description and crop damage Robust, C-shaped larvae of June beetles, 0.125 to 1.25 inches long, with a brown head capsule and prominent jointed legs. The body is an overall dirty white, but the last abdominal segments are blue-black internally. Damage from larval feeding appears as severed (cut) taproots in early season and as surface cavities on taproots later during the season.

Infestations are most likely when sugar beets follow grassy pastures. Grasses are the preferred host plants both for oviposition

and larval feeding. Some species require two or more years for egg-to-adult development, so old pasture can be infested with substantial populations of last-stage (large) grubs that are especially damaging to seedling sugar beet plants.

Scouting and thresholds No formal economic thresholds exist for white grub insecticide treatment decisions. There are no effective “rescue” treatments that can be applied postemergence in sugar beets for white grubs.

Management—biological control

- ◆ *Beauveria bassiana* (BotaniGard 22WP, BotaniGard ES, Mycotrol ESO, Mycotrol O, Mycotrol WPO – live spores of an insect-killing fungus)—See label for rates. PHI 0 days. Typically requires 7 to 10 days after first spray to see control. Begin treatment at first appearance of pest. Reapply as necessary.

Management—chemical control

- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ pyrethrins/*Beauveria bassiana* (BotaniGard Maxx, Xpectro OD)—See label for rates. Do not reapply for at least 3 days. In case of extreme pest pressure, wait a minimum of 24 hr before reapplying. Do not harvest until spray has dried.
- ◆ terbufos (Counter CR Lock’n Load, Counter 20G Lock’n Load, Counter 20G Smartbox, Counter 15G Lock’n Load, Counter 15G Smartbox) at 0.6 to 1.2 oz ai/1,000 row ft banded at planting. Apply in 5- to 7-inch band over the row and lightly incorporate. One application per year. Do not place granules in direct contact with the seed. Do not exceed 2 lb ai/a. –or– Apply at 0.6 to 1.2 oz ai/1,000 row ft, modified in-furrow at planting. Apply in furrow, 2 to 3 inches behind seed drop zone after some soil has covered the seed. One application per year. Do not place granules in direct contact with the seed. Do not exceed 2 lb ai/a.
- ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ zeta-cypermethrin—
 - (Mustang) at 0.05 lb ai/a planting application. Apply in furrow or in a T-Band (band over open furrow) in a minimum of 3 to 5 gal/a water. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foliar applications).
 - (Mustang Maxx) at 0.025 lb ai/a planting application. Apply in-furrow or make a 3 to 4 inch T-Band at planting in a minimum of 3 to 5 gal per acre. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr.

Sugar beet—Wireworm

Sugar beet wireworm (*Limonius californicus*)

Pacific Coast wireworm (*Limonius canus*)

Pest description and crop damage Smooth, hard-bodied, cylindrical, shiny tan “worms” about 1 inch long when mature. They have 3 pairs of small, thin legs behind the head; last abdominal segment with characteristic “keyhole” notch. Damage from larval feeding appears as seed destruction during germination. On older plants, wireworms scar and channel the taproot surface as well as chew winding tunnels into the taproot.

Sugar beets following grassy pastures are at highest risk for wireworm infestations, because, like white grubs, wireworms prefer grasses for egg laying and larval feeding, and wireworm larvae require 2 to 4 years for egg-to-adult development. Corn or cereals in rotation with sugar beets also increase the probability of wireworm infestations, especially if reduced tillage in rotational crops leaves high amounts of organic matter and crop residues in the soil.

Scouting and thresholds No formal economic thresholds exist for wireworm insecticide treatment decisions. In problem fields, use wireworm seed treatments for cereal crops grown in rotation with sugar beets. There are no effective “rescue” treatments that can be applied postemergence in sugar beets for wireworms. Use field history and wireworm baiting stations to determine need for at-planting insecticide treatment against wireworms.

Management—chemical control

- ◆ 1,3-dichloropropene (Telone II) and 1,3-dichloropropene/chloropicrin (Telone C-17, Telone C-35)—Preplant soil fumigants.
- ◆ azadirachtin—Some formulations are OMRI-listed for organic use.
 - (Debug Très) at 0.0375 to 0.1054 lb ai/a
- ◆ azadirachtin/pyrethrins (Azera, Azera Pro) at 0.0125 to 0.025 lb ai/a, and up to 0.044 lb ai/a under extremely heavy infestation. Dilution in a minimum of 30 gal of water per acre is recommended for conventional equipment. May be applied by air at the rate of 0.0125 to 0.025 lb ai/a in a minimum of 25 gal of water. Do not repeat more than every 5 to 7 days. OMRI-listed for organic use.
- ◆ chlorpyrifos (Lorsban 15G, Lorsban 15G Smartbox, Pilot 15G, Saurus) at 1.5 to 2 lb ai/a at planting. Suppression only. REI 24 hr. Do not apply granules in direct contact with seeds. Do not apply more than once per year. Apply in 4- to 5-inch band and incorporate into the top 0.5 to 1 inch of soil.
- ◆ clothianidin (NipsIt INSIDE, NipsIt SUITE)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ clothianidin/*Bacillus firmus* I-1582 (Poncho/Votivo) Application only by commercial seed treaters; no on-farm seed-treatment.
- ◆ clothianidin/beta-cyfluthrin (Poncho Beta)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ garlic oil (Garlic Barrier AG+)—See label for rates. Apply as preventive repellent treatment prior to insect infestation. Make first application at crop emergence and repeat on a 10- to 14-day schedule to maintain repellency effect.
- ◆ imidacloprid (Agrisolutions Nitro Shield, Agristar Macho 600 ST, Attendant 480 FS, Axxess Insecticide Seed Treatment, Dyna-Shield Imidacloprid 5, Gaucho 480 Flowable, Gaucho 600 Flowable, Senator 600FS, Sharda 5SC, and others)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ terbufos (Counter CR Lock’n Load, Counter 20G Lock’n Load, Counter 15G Lock’n Load, and others) at 0.6 to 1.2 oz ai/1,000 row ft banded at planting. Apply in 5- to 7-inch band over the row and lightly incorporate to 1 inch. One application per year. Do not place granules in direct contact with seed. Do not exceed 2 lb ai/a. PHI 110 days –or– Apply at 0.6 to 1.2 oz ai/1,000 row ft, modified in-furrow, at planting. Apply in furrow, 2 to 3 inches behind seed drop zone, after some soil has covered the seed. One application per year. Do not place granules in direct contact with seed. Do not exceed 2 lb ai/a.
- ◆ thiamethoxam (Cruiser 5FS)—Application only by commercial seed treaters; no on-farm seed-treatment application.
- ◆ zeta-cypermethrin—
 - (Mustang) at planting, 0.05 lb ai/a. Apply in furrow or in a T-Band (band over open furrow) in at least 3 to 5 gal/a water. PHI 50 days. Do not apply more than 0.15 lb ai/a per season (at planting/foiar applications).
 - (Mustang Maxx) at planting, 0.025 lb ai/a. Apply in-furrow or make a 3 to 4 inch T-Band at planting in a minimum of 3 to 5 gal per acre. PHI 50 days for tops or roots. Do not apply more than 0.075 lb ai/a per season. REI 12 hr.

Sunflower Pests

Timothy Waters

Latest revision—March 2020

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.

Protect pollinators: See How to Reduce Bee Poisoning from Pesticides.

Hybrid sunflowers are largely self-pollinating, but insect activity can increase seed yield. Most insecticides labeled for sunflowers are highly toxic to bees, so pest management programs should be conducted to prevent bee mortality. Spray applications should be restricted to very early morning or, preferably, late evening. Insecticides should not be applied to sunflowers in bloom until area beekeepers have been notified and allowed to remove bee hives from the area.

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

Sunflower—Banded sunflower moth

Cochylis hospes

Pest description and crop damage The adult has a dark band across yellowish tan forewings. The wingspan is about 0.5 inch. Early instar larvae are off-white; late instar larvae are pinkish to red with a brown head capsule. Sunflower heads are susceptible to infestation only during flowering. Larvae feed in the florets until the third instar, then tunnel into the seed. The larva usually enters near the top of the seed and leaves through the same opening after eating the contents. Each larva may destroy five to seven seeds. Areas of silken webbing on mature sunflower heads indicate the presence of banded sunflower moth larvae.

Management—cultural and biological control

Deep plowing sunflower stubble in fall in Manitoba reduced moth emergence the following season by about 80 percent. Research in North Dakota suggested that delaying planting sunflower until late May or early June may reduce infestation levels of the banded sunflower moth. Parasitic wasps attack both the eggs and larvae of the moth, and general predators in the sunflower field consume both larvae and eggs.

Management—chemical control

Banded sunflower moths tend to congregate around field margins just before plants flower. Treating field margins at this time can significantly reduce adults and minimize insecticide treatment costs and impacts on pollinators.

- ◆ *Bacillus thuringiensis* (*Bt*) (several brands)—Consult label for rate. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ chlorpyrifos (numerous products) at 0.5 to 0.75 lb ai/a. Two treatments are permitted at 7-day intervals. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.

- ◆ chlorantraniliprole (Prevathon) at 8 to 20 fl oz/a. Do not apply more than 0.2 lb ai/a of chlorantraniliprole per season. PHI 21 days. REI 4 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. Do not apply more than 0.06 lb ai/a or more than 0.045 lb ai/a after bloom begins. Less product is allowed if other cyhalothrin pesticides are used; see label. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Cutworm

Includes

Darksided cutworm (*Euxoa messoria*)

Dingy cutworm (*Feltia jaculifera*)

Redbacked cutworm (*Euxoa ochrogaster*)

Pest description and crop damage Forewings of the darksided cutworm are usually light, powdery, and grayish brown with indistinct markings. Larvae are pale brown dorsally and white on the ventral areas, with indistinct stripes on the sides. Redbacked cutworm adults have reddish brown forewings with bean-shaped markings. Larvae are dull gray to brown with two dull reddish stripes along the back. Dingy cutworm adults have dark brown forewings with bean-shaped markings. Hind wings of the male are whitish with a broad, dark outer margin; hind wings of the female are uniform dark gray. Larvae are dull brown with pale shading along the back. Cutworm damage normally consists of stems cut 1 inch below the soil surface to as much as 1 to 2 inches above the soil surface. Young leaves may be severely chewed by cutworms that climb up to feed on plant foliage.

Economic threshold Treatment is recommended at one cutworm per sq ft or when significant plant stand loss is noted.

Management—chemical control

- ◆ beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/a. A maximum of 0.22 lb ai/a per 7 days or 0.066 lb ai/a per season. PHI (pre-grazing and pre-foraging) 30 days. REI 12 hr.
- ◆ carbaryl (Sevin) at 1 to 1.5 lb ai/a. PHI 60 days. REI 24 hr.
- ◆ chlorpyrifos (numerous products) at 1 lb ai/a. Do not apply chlorpyrifos again within 10 days of the first application. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.02 to 0.05 lb ai/a. A total of 0.132 lb ai/a may be applied per season. PHI 28 days. REI 12 hr.
- ◆ gamma-cyhalothrin (Proaxis) at 0.0075 to 0.0125 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.

- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 5 to 8 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Grasshopper

Several species

Management—chemical control

- ◆ beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/a. A maximum of 0.22 lb ai/a per 7 days or 0.066 lb ai/a per season. PHI (pregrazing and preforaging) 30 days. REI 12 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 lb ai/a. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorantraniliprole (Prevathon) at 8 to 20 fl oz/a. Do not apply more than 0.2 lb ai/a of chlorantraniliprole per season. PHI 21 days. REI 4 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Seed weevil

Includes

Gray seed weevil (*Smicronyx sordidus*)

Red sunflower seed weevil (*Smicronyx fulvus*)

Pest description and crop damage Larvae of both species are small (0.12 inch long), cream-colored, legless and C-shaped. Red sunflower seed weevil adults are 0.1 inch long and reddish brown. Adults of the gray sunflower seed weevil are slightly larger (0.14 inch long) than *red sunflower seed weevil* and gray. Red sunflower seed weevils usually only partially consume seeds but separating undamaged from weevil-damaged seed is difficult. Most larvae drop from the head to the soil after completing their development, but a small percentage may remain in the seed to pupate, and those can cause heating and moisture problems at harvest and bin-filling time. Growers who find a seed weevil infestation should delay harvest to allow most weevil larvae to leave the seeds. Seeds infested by the gray seed weevil lack a kernel and seeds may be lost during harvest, due to their light weight. Because of the gray sunflower seed weevil's low population levels and low fecundity, it usually does not cause economic damage, especially in oil sunflower fields.

Economic threshold Economic thresholds vary with differences in plant population, insecticide and application cost, and sunflower's market price.

Management—chemical control

- ◆ beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/a. A maximum of 0.22 lb ai/a per 7 days or 0.066 lb ai/a per season. PHI (pre-grazing and pre-foraging) 30 days. REI 12 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 lb ai/a. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.

- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Stem weevil

Black sunflower stem weevil (*Apion occidentale*)

Sunflower stem weevil (*Cylindrocapturus adspersus*)

Pest description and crop damage Black stem weevil adults are black and 0.1 inch from snout tip to abdomen tip. The very narrow snout protrudes forward from the head, which is small in relation to the rather large, almost globose body. Larvae are 0.1 to 0.12 inch long at maturity, C-shaped, and yellowish. Sunflower stem weevil adults are about 0.19 inch long and grayish brown with white spots of various shapes on wing covers and thorax. The snout, eyes, and antennae are black. Larvae are 0.25 inch long at maturity. They are creamy white with a small, brown head capsule, usually found in a C-shape in the sunflower stalk. High infestations (25 per stem) of stem weevils interfere with nutrient and water transport, stressing the crop and reducing seed yield and oil content. Both species may transmit Phoma (black stem) disease.

Management—chemical control

- ◆ carbaryl (Sevin) at 1.0 to 1.5 lb ai/a. PHI 60 days. REI 24 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 to 0.75 lb ai/a. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Sunflower beetle

Zygogramma exclamationis

Pest description and crop damage Adults resemble Colorado potato beetle. The head is reddish brown, and the thorax is pale cream with a reddish-brown patch at the base. Each wing cover has three dark stripes that extend the length of the back. A shorter, lateral stripe ends at the middle of the wing in a small dot that resembles an exclamation point. The adult is 0.25 to 0.5 inch long. Larvae are yellowish green, humpbacked, and about 0.35 inch at maturity. Adult sunflower beetles damage plants soon after they emerge from hibernation. Damage to cotyledons is generally slight, but the first true leaves may be severely damaged or completely consumed. Fields may be severely defoliated if beetles are

numerous. Larvae of the sunflower beetle cause damage by chewing holes in the leaves.

Management—chemical control

- ◆ carbaryl (numerous formulations of Sevin) at 1 to 1.5 lb ai/a. Do not apply within 30 days of grazing or harvest for forage. PHI 60 days. REI 12 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 to 0.75 lb ai/a. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 5 to 8 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Sunflower maggot

Gymnocarena diffusa

Pest description and crop damage The adult fly is 0.5 inch long; eyes are bright green and wings have a yellow-brown mottle. Significant yield losses have not been demonstrated for this insect and treatment is generally not considered necessary.

Management—chemical control

- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 22 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Repeat as necessary for control. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ gamma-cyhalothrin (Proaxis) at 0.01 to 0.15 lb ai/a. Do not apply more than 0.06 lb ai/a or more than 0.045 lb ai/a after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr. (Adult only)

Sunflower—Sunflower moth

Homoeosoma electellum

Pest description and crop damage The adult is shiny gray to grayish tan, with a wingspan of about 0.75 inch. Each forewing has a small, dark dot near the center and two or three small, dark dots near the leading margin. Wings at rest are held tightly to the body, giving the moth a somewhat cigar shape. The larva has alternate dark and light longitudinal stripes on a light brown body and is about 0.75 inch long at maturity. Young larvae feed primarily on florets and pollen; older larvae tunnel through immature seeds and other parts of the head. A single larva may feed on from three to 12 seeds and forms tunnels in both the seeds and head tissue. Larvae spin silken threads which bind with dying florets and frass to give the head a trashy appearance. Severe larval infestations can cause 30 to 60 percent loss; in some cases, the entire head can be destroyed.

Economic threshold Chemical control is recommended at one to two adults per five plants at the onset of bloom or within 7 days of

the adult moth's first appearance. Fields in bloom or that bloom 2 weeks or more after the first adult moth appearance have very low potential for damage despite the presence of moths in threshold numbers. Pheromone traps are available to scout for this pest.

Management—chemical control

- ◆ *Bacillus thuringiensis* (Bt) (several brands)—Consult label for rate. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ carbaryl (Sevin) at 1.0 to 1.5 lb ai/a. PHI 60 days. REI 24 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 to 0.75 lb ai/a. Two treatments are permitted at 7-day intervals. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ chlorantraniliprole (Prevathon) at 8 to 20 fl oz/a. Do not apply more than 0.2 lb ai/a of chlorantraniliprole per season. PHI 21 days. REI 4 hr.
- ◆ deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/a. Do not apply more than 0.045 lb ai/a per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. REI 12 hr. PHI 28 days.
- ◆ gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. Do not apply more than 0.06 lb ai/a or more than 0.045 lb ai/a after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Woolly bear caterpillar (Isabella tiger moth)

Black banded woolly bear (*Pyrrhactica isabella*)

Pest description Adults have tan wings with faint black spots and black spots on the back of the abdomen. Larvae are fuzzy, with black bands at the front and rear and a reddish band in the middle. Larvae are generalist plant feeders.

Management—chemical control

- ◆ carbaryl (Sevin) at 1 to 1.5 lb ai/a. PHI 60 days. REI 24 hr.
- ◆ chlorpyrifos (numerous products) at 0.5 to 0.75 lb ai/a. Two treatments are permitted at 7-day intervals. Do not graze or feed treated forage. PHI 42 days. REI 24 hr.
- ◆ chlorpyrifos/lambda-cyhalothrin (Cobalt Advanced) at 16 to 38 fl oz/a. Do not graze or feed treated forage. PHI 45 days. REI 24 hr.
- ◆ esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. Do not exceed 0.2 lb ai/a per season. PHI 28 days. REI 12 hr.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/a. Do not apply more than 0.12 lb ai/a per season or more than 0.09 lb ai/a after bloom begins. PHI 45 days. REI 24 hr.
- ◆ lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/a. Do not apply more than 0.12 lb ai/a per season of lambda-cyhalothrin or more than 0.2 lb ai/a of chlorantraniliprole. PHI 45 days. REI 24 hr.

For more information:

Knodel, J., Charlet, L., and Gavloski, J. Integrated Pest Management of Sunflower Insect Pests In the Northern Great Plains. 2015. North Dakota State University Extension Service. E- 1457. <https://www.>

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