Tree Fruit Crops

Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest

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Mite	Egg	Summer adult	Stage and location of overwintering form	Degree of webbing	Comments
Clover mite *Bryobia praetiosa*	Red, spherical, and smooth	Dark brown to greenish, flattened mite with front legs of female much longer than other legs. Posterior marginal setae are drop-shaped on the adult female.	Overwinter as larvae (red), nymphs (red-green), and adults (red-green) in soil, litter, and on bark of trees. The larva has slender dorsal setae.	Very little	Not too numerous on fruit trees. May migrate into homes in spring and fall. Often confused with *B. rubrioculus.*
Brown mite *Bryobia rubrioculus*	Red, spherical, and smooth	Similar to *B. praetiosa*, but the posterior setae are fan-shaped.	Overwinter as eggs on twigs and branches. Larvae, nymphs, and adults may be found in litter and on bark of trees. The larva has fan-shaped dorsal setae but otherwise looks much like that of *B. praetiosa*.	Very little	Found primarily on trees and shrubs and may be quite abundant in orchards.
European red mite *Panonychus ulmi*	Red, slightly flattened, with a dorsal stalk	Female a brick-red color with obvious white tubercles on the dorsal surface of the body from which hairs arise.	Overwinter as red eggs on twigs and branches.	Very little	Feed heavily on wild rose bushes; wild rose can be a source of infestation if orchard boundaries are not sprayed.
Yellow spider mite *Eotetranychus carpini borealis*	Translucent, spherical	Pale yellow, with 2 or 3 paired fields of small dark spots on body. The adults are smaller than the adults of *Tetranychus urticae*. Both species may be on same leaf.	Overwinter as yellow females on trees and , in ground litter.	Very little	Usually present in small colonies on leaves.
McDaniel spider mite *Tetranychus mcdanieli*	Whitish (appears pale green on leaf) and spherical.	Greenish to yellowish with two small dark spots near middle of body and two larger spots near posterior	Orange females overwinter on trees or in ground litter.	Extensive	May be a serious problem on fruit at harvest time.

Twospotted spider mite *Tetranychus urticae*	Whitish (appears pale green on leaf) and spherical.	Greenish to yellowish with two large, dark spots on body; Body globular.	Overwinter as orange females on trees or in ground litter. Orange females may be found as early as mid-August.	Extensive	Feed most commonly on undersides of leaves.

Bud development chart

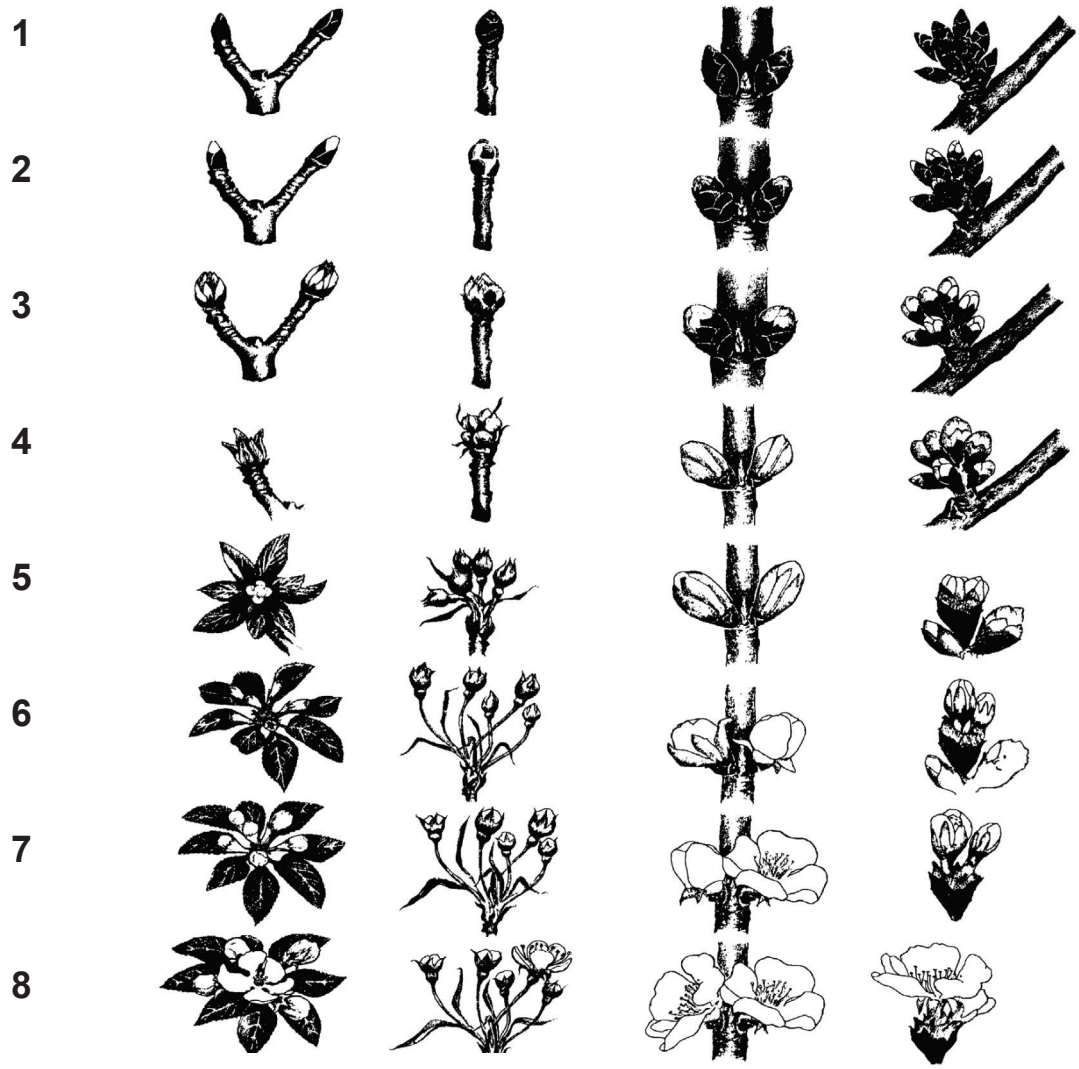

Figure 1. Stages of bud development

Key to bud development stages

Stage	Apple	Pear
Dormant	1-2	1
Delayed-dormant	3-4	2-3
Prepink	4-5	4-5
Pink	6-7	6-7
Bloom	8	8
Petal fall	8+	8+

This chart illustrates the various stages of flowering for common tree fruits in the PNW. The chart may be used to time pesticide application for the proper and effective control of insect pests, while minimizing potential adverse effects on honeybee populations. Proper timing of pesticide applications is critical for effective pest management. Proper timing also is essential to protect honeybees that are present during bloom.

Stage	Stone fruits
Dormant	1
Delayed-dormant	2
Prebloom	3-6
Bloom	7-8
Petal fall	8+

Key to bud development stages
Avoid pesticide applications during bloom to protect honeybees. For many insect pests, including mites and scale, pesticide applications made during the dormant or delayed-dormant periods are most effective. in particular, horticulatural oil (dormant oil) applications made during this time that achieve good coverage can effectively smother mite eggs and scale insects that may be present.

Applying Pesticide on Fruit Tree Pests

Read carefully the entire label of each material that is to be used.

Under present federal regulations, it is illegal to apply any pesticide in a manner, rate, or dilution that is not recommended on the label. Check with the county agent or the agricultural research center in your area if there are any discrepancies between recommendations in this handbook and a pesticide label with regard to rates, dilutions, or manner of application.

Pests and strategies for their management vary throughout the Pacific Northwest. Complete spray schedules are available for the different growing regions of Washington, Oregon, and Idaho. The following insecticides and miticides are the general materials that are available for pest control—not all materials registered for a given use are listed. Specific materials and formulations may be more effective in certain areas of the Pacific Northwest than in others. Be sure to check with your county agent or agricultural research center in regard to specific management programs. Not all label restrictions can be listed here. You must read the label to ensure legal use.

COMMERCIAL GROWERS: The following materials and formulations presently are registered for use in the Pacific Northwest states for pest control in the various orchard crops. Application rates in the tables are based on current spray practices of up to 100 gallons of water per acre per application, except where the label specifies otherwise or for dormant/ delayed-dormant sprays where the historical dilute spray volumes of up to 400 gal water/acre are still recommended. The label rates are given per acre and must never be exceeded. Tree size, amount of foliage, type of equipment used, and other factors are important in determining the amount of spray solution to use per acre. When applying concentrate sprays (spray volumes of ≤100 gal water/a), use the per-acre rates or a modification of these rates according to the label. IRAC mode of action group numbers [Group X] are given for each of the chemicals suggested in the following list. To reduce the development of pesticide resistance, users should choose insecticides from these groups in rotation, using where possible, **at least three different registered groups in succession.** (see http://www.irac-online.org/teams/mode-of-action/)

Apple Pests

Nik Wiman, Heather Stoven, and Chris Adams

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INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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.

Pre-mixed pesticide combinations

Commercially packaged insecticide premixes should not be used in commercial orchard crops from a pesticide resistance management perspective. To prolong the effectiveness of insecticides, an effective insect resistance management program must be part of an IPM program that involves sampling and monitoring, treatment thresholds, biological and cultural control. Do not use pesticides with the same mode of action on back-to-back generations of a pest. Home orchardists should seek to identify specific pests and select appropriate pesticides for the targeted pest.

Notes

All rates listed are for formulated products, unless specifically stated otherwise.
Reference to stages (0–7) refers to the bud development chart in this handbook.

Protect pollinators: Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard. See How to Reduce Bee Poisoning from Pesticides.

Mite identification: See Field Characteristics of Fruit-Tree-Attacking Spider Mites in the PNW.

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

Apple—Apple-and-thorn skeletonizer

Choreutis pariana

Pest description and crop damage Adult moth is reddish brown, with a wingspread less than 0.5 inch, and irregular light and dark bands on the wings. Larvae are 0.5 inch long, yellowish to greenish, with black spots and a yellow-brown head. Pupae are yellow to brown with a white silken cocoon. Larvae skeletonize and roll leaves. Damaged leaves are brown and papery and drop prematurely. Larvae feed on apple, crabapple, and cherry as well as a wide variety of native hosts such as hawthorn, willow, birch and mountain ash.

Biology and life history Adult moths overwinter in crevices in the tree. They lay eggs in small bunches on the undersides of leaves. The larvae emerge and feed on the underside of the leaves. They then move to the top surface to feed, often tying the sides together creating a “rolled” effect. There can be more than one caterpillar in the rolled leaf that becomes skeletonized. After 3 to 4 weeks, larvae pupate in the rolled leaf. Adults emerge after about 2 weeks to start a new generation. There are at least two generations per year.

Scouting and thresholds Watch for signs of skeletonizing, which from a distance looks like the leaf tips have been burned.

Management—biological control

There are many natural enemies of this pest. Avoid broad-spectrum sprays that would disrupt biological control.

Management—cultural control

Larvae and pupae are easily removed from rolled leaves. Remove heavily infested twigs.

Management—chemical control: HOME USE

No chemicals are labeled for specific control of this pest.

Management—chemical control: COMMERCIAL USE

Insecticides used for codling moth or apple maggot also control this pest.

Apple—Aphid

Includes
Apple grain aphid (*Rhopalosiphum oxyacanthae*)
Apple aphid (*Aphis pomi*)
Rosy apple aphid (*Dysaphis plantaginea*)

See also:
Apple—Woolly apple aphid

Pest description and crop damage Apple grain aphid is light green with a distinctive green stripe down the middle of the back. Apple grain aphids infest apple buds in the early part of the season, often becoming apparent at green tip. Apple grain aphid is typically not economically damaging, and its early appearance may jumpstart aphid natural enemy populations. Green apple aphid is dark green and is present throughout the growing season on foliage. It may be more problematic on green and yellow apple cultivars. Heavy populations can feed directly on the fruit, which can mark fruit, or honeydew from this aphid can cause sooty mold growth.

Rosy apple aphids are rose-purple. Their feeding causes severe leaf curling, along with honeydew and sooty mold. Fruits of certain varieties can be stunted and deformed by early-season feeding. The best time for control is before bloom. Once leaves are severely curled, aphids are extremely difficult to kill.

Scouting and thresholds Begin observing growing shoots in late May as shoot leaves are expanding rapidly. About four to five infested leaves per shoot indicates a problem. Aphid identification is necessary to guide treatment decisions as apple grain aphid and green apple aphid are typically less damaging.

Management—biological control

Aphids have many natural enemies including lady beetles, syrphid fly larvae, green lacewings, and parasitoid wasps. Avoid broad-spectrum insecticide applications that disrupt these controls.

Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen because aphids prefer succulent new growth.

Home orchardists: Wash aphids from plants with a strong stream of water or by hand-wiping.

Management—chemical control: HOME USE

Stages 0-1: Egg control with dormant & delayed-dormant sprays

Apply sprays during dormant or delayed-dormant period (March to April). Do not apply after pink appears in buds. Use enough water to cover the entire tree thoroughly including small limbs and shoots.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Spring and summer

If leaves become severely curled by rosy apple aphids, control is very difficult. Do not treat after blossoms open.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 0-1: Egg control with dormant & delayed-dormant sprays

- diazinon (Diazinon 50W) at 4 lb/A + horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. Dormant or delayed dormant use of diazinon is limited to one application. Delayed-dormant control with oil, plus an organophosphate, is most effective for scale control. Organophosphate insecticides are highly toxic to birds and fish. Avoid drift to open water and maintain buffers. REI 4 days. [Group 1B]
- Narrow-range horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. REI varies by formulation; see label. Some formulations are OMRI-listed for organic use.
- lime sulfur (calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil at 6 to 8 gal/A in up to

400 gal water. REI 2 days. Some formulations are OMRI-listed for organic use.

- pyriproxyfen (Esteem 35 WP) at 4 to 5 oz/A in up to 400 gal water. Apply by ground with airblast equipment in a minimum of 50 gal/A. Thorough coverage is critical for control. It is essential to use adequate water volume to ensure thorough coverage. Apply at delayed-dormant through pink. REI 12 hr. [Group 7C]

Stages 3-4: Prepink & tight cluster sprays

- acetamiprid (Assail 70WP) at 1.1 to 1.7 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. [Group 4A]
- diazinon (Diazinon 50W) at 4 lb/A in up to 100 gal water per application. Dormant or delayed dormant use of diazinon is limited to one application. REI 4 days. [Group 1B]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. For rosy apple aphid begin applications at green tip to early pink. REI 12 hr. PHI 3 days. [Group 28]
- flonicamid (Beleaf 50 SG) at 2 to 2.8 oz/A in up to 100 gal water per application. Use a minimum of 50 gal water when applied by ground. Do not apply more than three applications per season. REI 12 hr. [Group 29]

Spring and summer

- acetamiprid (Assail 70WP) at 1.1 to 1.7 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- *Chromobacterium subtsugae (*Grandevo) at 2 to 3 lb/A. Under heavy pest populations, apply a knockdown insecticide prior to or in a tank mix, use the higher label rates, shorten the spray interval, and/or increase the spray volume to improve coverage. REI 4 hr PHI 0 day. OMRI-listed for organic use.
- clothianidin (Belay) at 4 to 6 fl oz/A in up to 100 gal water per application. Do not apply more than 12 fl oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- diazinon (Diazinon 50W) at 4 lb/A in up to 100 gal water per application. Do not apply more than one in-season application per season. REI 4 days. PHI 21 days. [Group 1B]
- flonicamid (Beleaf 50 SG) at 2.0 to 2.8 oz/A. Use a minimum of 50 gal water when applied by ground. Do not exceed three sprays per season. REI 12 hr. PHI 21 days. [Group 29]
- imidacloprid (Admire Pro) at 2.8 fl oz/A in up to 100 gal water per application. Do not use within 10 days prior to bloom or when bees are actively foraging. Do not exceed 14 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 4A]
- pyridaben (Nexter) at 6.6 to 10.67 oz/A in up to 100 gal water per application. Only one application per season. REI 12 hr. PHI 25 days. [Group 21]
- pyriproxyfen (Esteem 35 WP) at 3 to 5 oz/A per 100 gal water. Do not exceed two applications of Esteem 35 WP per acre per season. REI 12 hr. PHI 45 days. [Group 7C]
- spirotetramat (Movento) at 6 to 9 fl oz/A in up to 100 gal water per application. Do not exceed 25 fl oz/A per growing season. Do not apply until after petal fall. REI 24 hr. PHI 7 days. [Group 23]
- sulfoxaflor (Transform WG) at 0.75 to 1.5 oz/A in up to 100 gal water per application. No more than four applications per season. PHI 7 days [Group 4C]
- tolfenpyrad (Bexar) at 17 to 21 oz/A in up to 100 gal water per application. See supplemental label. Aerial applications not allowed. No more than two applications. REI 12 hr. PHI 14 days. [Group 21A]
- thiamethoxam (Actara WDG) at 4.5 to 5.5 oz/A in up to 100 gal water per application. Do not exceed 16.5 oz/A per season. Actara is extremely toxic to bees. REI 12 hr. PHI 35 days. [Group 4A]
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 6 to 7 oz/A in up to 100 gal water per application. Do not apply exceed 16 oz/A per season and do not use an adjuvant within 60 days of harvest. REI 12 hr. PHI 35 days. [Group 4A & 28]

Apple—Apple ermine moth

Yponomeuta malinellus

Pest description and crop damage Apple ermine moth is an invasive insect from Eurasia that has established in the PNW. The adult insect is a long, narrow moth up to 0.4 inch long, wings are white with small black spots, and antennae are long and backward-sweeping. The larvae are greenish-yellow caterpillars, 0.5 inch long, with two rows of black spots down their body. The pupae are found in spindle-shaped white cocoons. The larvae consume foliage within communal webs or tents. These tents are much smaller in size than those of the tent caterpillars or fall webworm. This pest primarily affects unmanaged trees. The larvae could cause damage in commercial orchards with minimal insecticide inputs.

Biology and life history The insect overwinters as an immature larva under egg masses on the bark. Females lay 10 to 80 eggs in each cluster in overlapping rows like shingles. The egg mass forms a flattened, slightly convex oval about 0.5 inch in diameter. They are initially yellow, but age to red then gray in color. Larvae emerge at bud break and commence mining the leaves. Later, larvae tie together leaves with webbing to make nests up to 3 inches across. Each nest contains several caterpillars. New nests are made as leaves in old ones are consumed. The caterpillars pupate in clusters within webbing, beginning around June. Adults emerge from late June onwards, with females laying eggs into the fall. There is only one generation per year.

Management—cultural control

Pick off or prune out any egg masses observed on the bark in the fall. Prune out and destroy nests (in May) when practical. Also remove any pupating clusters when noticed.

Management—chemical control: HOME USE

- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Products used for leafroller and codling moth management will likely provide good control (including softer options). The following are labeled:

- beta-cyfluthrin (Baythroid XL) at 2.4 to 2.8 fl oz/A in no less than 100 gal water per application. Do not apply more than 2.8 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 3]
- cyfluthrin (Tombstone) at 2.4 to 2.8 fl oz/A in no less than 100 gal water per application. Do not exceed 2.8 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 3A]
- esfenvalerate (Asana XL) at 4.8 to 14.5 oz/A in up to 100 gal water per application. REI 12 hr. PHI 21 days.

Apple—Apple maggot

Rhagoletis pomonella

Pest description and crop damage The apple maggot is a small fly native to the northeastern United States and Canada, where it originally fed on hawthorn. It was not until 100 years after apples were introduced to North America that it was found feeding on apples. Today, it is a key pest of apples in northeastern regions, where several insecticide sprays are necessary to produce fruit free from maggot injury and contamination. It has since migrated to the PNW, where it was originally found in Portland in 1979. By 2000, it was found in most western Oregon and Washington counties, where it is a very destructive pest. The apple maggot remains a threat to the commercial Northwest apple industry in the Columbia River Basin. The maggots develop in apples, quince, and the fruits of native and ornamental hawthorn. The apple maggot also may occur incidentally in pear, plum, and tart cherry. Early cultivars of apples are particularly susceptible to damage. There is a quarantine on the movement of fruit from Washington and Oregon counties known to have this pest. Check with your State Department of Agriculture for details.

The adult fly is about the size of a housefly. The body is black, and the abdomen has distinctive white bands. The wings are banded with black. The eyes of the adult fly are dull red. The larva is cylindrical, tapering to a pointed, non-distinct head, and is white except for two dark mouth hooks. The pupa appears similar to a large, dark brown grain of wheat. Eggs are small, white and smooth, but are rarely seen, as they are laid under the skin of host fruit.

The larvae tunnel through the fruit, leaving a brown, threadlike, irregular trail. The tunnels enlarge as the larvae grow. The tunnels serve as entry points for decay organisms, which cause internal rotting. Fruit of soft-fleshed, early maturing varieties often drop prematurely in response to damage. In hard fleshed, late maturing varieties, internal decay may not occur until after the apple drops.

Biology and life history The maggot spends the winter in the soil in the pupal stage. As the soil warms, it begins to develop, and in June, the adults begin to emerge. Emergence continues through the summer, and flies are active until October. The adults feed on honeydew produced by aphids or other insects, and after seven to ten days mate and lay eggs. Eggs are laid singly under the skin of an apple, causing a small, brown, decayed area to develop. Eggs hatch in two to ten days, and larvae commence tunneling through the fruit. Development is completed in twenty to thirty days, at which point the fruit often drops to the ground. The larvae then leave the fruit and burrow into the soil to pupate. There is usually only one generation per year.

Scouting and thresholds The most effective monitoring method involves the use of sticky traps, either yellow or red in color. Yellow sticky cards baited with ammonium carbonate chargers are effective (this same trap/lure combination is also used for cherry fruit fly and walnut husk fly). A red plastic sphere (mimicking an apple) covered with sticky glue is also effective and can also be enhanced with the charger. Hang traps in the outer third of the canopy by mid-June and inspect regularly. A phenology model for this pest can be used to predict first emergence of flies (uspest.org). Traps can be used to verify emergence predictions from the model. Note that a low fly population may not be detected using the traps, so place the trap in a location where there is a history of activity or damage to obtain the best representation of emergence timing.

Management—biological control

Because the larvae are protected inside the apple fruit as they develop, little effective biological control has been observed. Larvae and pupae may suffer mortality from natural enemies such as nematodes and entomopathogenic fungi while they are in the soil.

Management—cultural control

Sanitation is one of the most effective management strategies for home orchards. Regularly inspect fruit while it is on the tree, removing and destroying any maggot-infested fruit. Destroy infested fruit on the ground, or the maggots will continue to develop and pupate in the soil. Pick up and destroy fallen apples at weekly intervals from early August until harvest. In home orchards, traps can be used to manage low density fly populations by trapping adults before they reproduce. Place one apple maggot trap in each small apple tree (less than 8 feet tall), two to four traps on medium-sized trees, or six to eight traps on trees 20 to 25 feet tall. Clean traps weekly and replace adhesive every 3 weeks. This technique is not effective against high fly populations. In the home orchard, fruit can be protected against damage by bagging individual fruits by mid-June using plastic or mesh baggies.

Management—chemical control: HOME USE

Apply first in early July.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.

- pyrethrins—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

In addition to pre-mixed bait sprays such as GF-120, commercial insect baits such as Nu-Lure and Monterey insect bait can be mixed with some materials (particularly Group 5), and sprayed with coarse droplets. Flies are attracted to the bait droplets to feed.

Spring and summer

- acetamiprid (Assail 70WP) at 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- beta-cyfluthrin (Baythroid XL) at 2.4 to 2.8 fl oz/A in no less than 100 gal water per application. Do not apply more than 2.8 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 3]
- chlorantraniliprole (Altacor) at 3.0 to 4.5 oz/A in no less than 100 gal water per application. Do not apply more than 9 oz/A per growing season. Do not use an adjuvant within 60 days of harvest. REI 4 hr. PHI 5 days. [Group 28]
- clothianidin (Belay) at 4 to 6 fl oz/A in up to 100 gal water per application. Do not apply more than 12 fl oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- cyclaniliprole (Verdepryn 100SL) at 5.5 to 11 fl oz/A in 100 to 200 gal water. Suppression only. REI 4 hr. PHI 7 days [Group 28]
- cyfluthrin (Tombstone) at 2.4 to 2.8 fl oz/A in no less than 100 gal water per application. Do not exceed 2.8 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 3A]
- esfenvalerate (Asana XL) at 4.8 to 14.5 oz/A in up to 100 gal water per application. REI 12 hr. PHI 21 days.
- gamma-cyhalothrin (Declare) at 1.02 to 2.05 fl oz/A in enough water to achieve full coverage. REI 24 hr. PHI 21 days. [Group 3A]
- indoxacarb (Avaunt) at 5 to 6 oz/A in up to 200 gal water per application. Make no more than three applications prior to hand-thinning. No hand thinning after the fourth application. Make no more than four applications per growing season. Do not apply more than 24 oz/A per growing season. For use in low- to moderate-pressure situations, with alternate control measures such as mating disruption. REI 12 hr. PHI 14 days. [Group 22]
- kaolin clay (Surround WP) at 25 to 50 lb/A applied as a spray to leaves, stems, and fruit. Continue applications every 7 to 14 days to assure adequate coverage on newly growing plant surfaces. Kaolin acts as a repellant to target pests. REI 4 hr. PHI 0 day. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz in enough water to achieve thorough coverage. REI 24 hr. PHI 21 days. [Group 3]
- spinetoram (Delegate WG) at 6 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per season. REI 4 hr. PHI 7 days. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz /A per season. REI 4 hr. PHI 7 days. [Group 5]. OMRI-listed for organic use.
- spinosad (GF-120) at 10 to 20 oz/A. Bait spray, follow label directions for dilution rate and nozzle size. Begin applications when traps indicate presence of flies or use the phenology model. PHI 7 days. [Group 5] OMRI-listed for organic use.
- zeta-cypermethrin (Mustang Maxx) at 1.28 to 4.0 fl oz/A in a minimum of 100 gal water for dilute spray. REI 12 hr. PHI 14 days. [Group 3A]

Apple—Apple rust mite

Aculus schlechtendali

Pest description and crop damage Extremely small, wedge-shaped mite, which is tan to amber colored. Magnification is required to see this mite. Feeding makes leaves look off-color, sometimes with a silvery sheen. Leaves roll lengthwise. Feeding shuts down terminal growth. Populations of apple rust mite should be tolerated because rust mites are an important alternate food source for predatory mites. However, rust mite can cause russeting on 'Golden Delicious' or other green/fair colored apples and some control may be required for certain apple varieties.

Biology and life history These mites overwinter as adult females under bud scales and in bark crevices. When growth begins, they move out onto the leaves to feed, and produce several generations. In late July or early August, they return to bud scales and bark crevices to diapause/overwinter.

Management—biological control

Conserve predatory mites, such as *Typhlodromus* spp., which provide effective control, by avoiding broad-spectrum insecticide applications.

Management—chemical control: HOME USE

Spring and summer (note: treatments rarely necessary)

- carbaryl—Highly toxic to bees.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Stages 5-6: Pink spray (note: treatments rarely necessary)

- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb/A in up to 100 gal water per application. Do not apply more than two times per growing season. REI 2 days. [Group 12B]
- fenpyroximate (FujiMite SC) at 2.0 pints/A in a minimum of 100 gal water per application. Only one application per season. Suppression only. REI 12 hr. [Group 21A]
- kaolin clay (Surround WP) at 25 to 50 lb/A applied as a spray to leaves, stems, and fruit. Continue applications every 7 to 14 days to assure

adequate coverage on newly growing plant surfaces. Kaolin acts as a repellant to target pests. Some formulations are OMRI-listed for organic use. REI 4 hr.

- pyridaben (Nexter) at 6.6 to 10.67 oz/A in up to 100 gal water per application. Only one application per season. REI 12 hr. [Group 21]
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A in a minimum of 100 gal water per application. Do not apply more than one application per growing season. REI 12 hr. [Group 23]

Spring and summer (note: treatments rarely necessary)

Also, see control recommendations for pink stage bud development.

- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb/A in up to 100 gal water per application. Do not apply more than two times per growing season. REI 2 days. PHI 14 days. [Group 12B]
- fenazaquin (Magister SC) at 32 to 36 oz/A in no less than 50 gal water. No more than one application per year, do not apply before petal fall. REI 12 hr. PHI 7 days. [Group 21A]
- pyridaben (Nexter) at 6.6 to 10.67 oz/A in up to 100 gal water per application. Apply as populations begin to build, between petal fall and harvest. Do not exceed one application per season. REI 12 hr. PHI 25 days. [Group 21]
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A in a minimum of 100 gal water per application. Do not apply more than one application per growing season. REI 12 hr. PHI 7 days. [Group 23]
- spirotetramat (Movento) at 6 to 9 fl oz/A in up to 100 gal water per application. Do not exceed 25 fl oz/A per growing season. Do not apply until after petal fall. REI 24 hr. PHI 7 days. [Group 23].

Apple—Armyworm and Cutworm

Includes
Bertha armyworm (*Mamestra configurata*)
Spotted cutworm (*Xestia c-nigrum*)
Variegated cutworm (*Peridroma saucia*)
Winter cutworm (*Noctua pronuba*)

Pest description and crop damage Several species of armyworm and cutworm attack tree fruits (see also: Lacanobia fruitworm). The most common species found in tree fruit in the PNW are the bertha armyworm and the spotted cutworm. Winter cutworm is a relatively new cold-tolerant species that may at times occur in orchards (see EM9139, https://extension.oregonstate.edu/catalog/pub/em-9139-winter-cutworm-new-pest-threat-oregon). The adults are large moths ranging in color from gray to brown with spots on the wings. The adult moths are attracted to lights. Larvae are dirty white, reddish, gray or black caterpillars up to 2 inches long. The larvae of these moths feed on buds and leaves, chewing holes in buds and ragged holes out of leaves. They also feed on the growing tips, particularly on small trees or in high density plantings. On larger trees, most of the feeding is on the lower branches, and may be concentrated to a few stems or limbs, while other stems are undamaged.

Biology and life history Weeds are the preferred source of food for these larvae, and eggs typically are laid on weeds around the trees. Eggs are laid in large clusters. Depending on species, they may overwinter as pupae or larvae in the soil. The larvae spend the day in the soil, and then climb up the tree during the night to feed, often following the same path.

Management—cultural control

Control weeds, grasses, and debris in the orchard that provide cover. Natural enemies of cutworm include birds and spiders. Hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime. Caterpillars can be trapped by tying plastic wrap tightly around branches and trunk, then applying Tanglefoot or a similar sticky material to the plastic wrap. Remove these in the fall.

Management—chemical control: HOME USE

Spring and summer

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 3-4: Prepink & tight cluster sprays

- *Bacillus thuringiensis* var. *kurstaki* (*Btk*) (Dipel DF, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* materials two to three

times, beginning at prepink, repeating at pink and petal fall. Apply *Btk* only when temperature exceeds 60°F. REI 4 hr. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]

- indoxacarb (Avaunt) at 5 to 6 oz/A in up 100 gal water per application. Make no more than three applications prior to hand-thinning. No hand thinning after the fourth application. Make no more than four applications per growing season. Do not apply more than 24 oz/A per growing season. REI 12 hr. [Group 22]
- peptide GS-omega/kappa-Hxtx-Hv1a (Spear-Lep) at 1 to 2 pints/A. Biological insecticide that should be tank mixed with equal parts of Bt. PHI 0 day. REI 4 hr.

Spring and summer

- acetamiprid (Assail 70WP) at 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*) (Dipel DF, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* only when temperature exceeds 60°F. REI 4 hr. PHI 0 days. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]
- peptide GS-omega/kappa-Hxtx-Hv1a (Spear-Lep) at 1 to 2 pints/A. Biological insecticide that should be tank mixed with equal parts of *Bt.* PHI 0 days. REI 4 hr.
- phosmet (Imidan 70W) at 2.1 to 5.7 lb/A in up to 100 gal water per application. REI/PHI 7 days. [Group 1B]
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications or 28 oz/A per growing season. REI 4 hr. PHI 7 days. [Group 5]

Apple—Blister mite

Includes
Appleleaf blister mite (*Eriophyes mali*)
Pearleaf blister mite (*Eriophyes pyri*)

Pest description and crop damage Adults of these mites (Eriophyidae) are very tiny and can be seen only under magnification. They are light to amber yellow, cylindrical, tapered at the posterior end, with two pairs of short legs at the front of the body. The overall appearance is that of a small worm. Immatures appear similar to the adult but are smaller. Feeding on leaves causes reddish to yellowish green blisters; blisters turn brown or black as the tissue dies later in the season. Leaves may drop prematurely. Loss of foliage weakens trees, reduces shoot growth, and interferes with fruit maturation and fruit bud formation. Feeding on fruit causes russeted, sunken spots.

Biology and life history Blister mites overwinter as mature females under outer bud scales. As buds swell in the spring, the mites burrow inside to feed. After petal fall, they move to leaves or fruit, causing the characteristic blisters. Several generations per year may develop within the blisters. As they become more crowded, mites move to growing terminals, where their feeding produces more blisters. Fruit damage is caused by feeding injury to buds before bloom—mites do not reside in the blisters on fruit. Mites move from tree to tree, perhaps by wind or carried on birds or insects.

Scouting and thresholds Scouting for blister mite is not effective during the current growing season, as by the time blisters are noticed the damage is done. Plan on taking action the following fall or winter if fruit damage is noted. Sufficient control usually is achieved by midsummer by biological agents.

Management—biological control

Phytoseiid predator mites almost always keep mites under control if broad-spectrum insecticide applications are avoided. Heavy rain and cold weather also suppress mite numbers.

Management—cultural control

Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Mites may be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites. Small, whitish eriophyid mites overwinter under bud scales and produce blisters on leaves. Fruit is sometimes russeted and deformed.

Management—chemical control: HOME USE (note: treatments rarely necessary)

Stages 0-1: Egg control with delayed & delayed-dormant sprays

Apply sprays during dormant or delayed-dormant period (March to April). Do not use after pink appears in buds. Use enough water to cover all of the tree thoroughly including small limbs and shoots.

- superior-type oil—Some formulations are OMRI-listed for organic use.
- sulfur—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE (note: treatments rarely necessary)

Postharvest/prior to leaf drop:

- horticultural mineral oil at 4 to 8 gal/A plus lime sulfur at 12 gal/A in up to 400 gal water per application. [JMS Stylet-Oil- OMRI]
- sulfur (dry flowable, micronized)—Formulations vary; see label for rates. Apply with suitable spray oil during bud dormancy only. REI 24 hr. Some formulations are OMRI-listed for organic use. Potential for phytoxicity with hot temperatures and with sensitive apple varieties.

Management—chemical control: COMMERCIAL USE (note: treatments rarely necessary)

Stages 0-1: Egg control with delayed & delayed-dormant sprays

- lime sulfur (calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil at 4 to 8 gal/A up to 400 gal water per application. REI 2 days. Some formulations are OMRI-listed for organic use. Potential for phytotoxicity with hot

temperatures.

- sulfur (dry flowable, micronized)— Formulations vary; see label for rates. Apply with suitable spray oil during bud dormancy only. REI 24 hr. Some formulations are OMRI-listed for organic use. Potential for phytoxicity with hot temperatures and with sensitive apple varieties.

Apple—Campylomma bug

Campylomma verbasci

Pest description and crop damage Campylomma bug is not native to the US, but has been present since the late 1800s. Adults are brownish-yellow and about 0.1 inch long, very mobile and active. Nymphs are small, green, and fast moving and about 0.1 inch long when mature. The mature nymphs resemble aphids in some ways but are far more active. Feeding by nymphs causes dimpling and distortion of fruit.

Biology and life history Campylomma bug females lay their overwintering eggs into crevices in the bark of the tree where the eggs lie dormant until spring. The eggs begin to hatch prior to bloom and developing nymphs can scar fruit with early feeding activity on the tiny maturing fruitlets. Campylomma bug remains on the tree host through the bloom period until late spring when they move to herbaceous host plants. Campylomma bug is known as mullein plant bug, after one of its preferred herbaceous hosts – the noxious weed common mullein. Weeds and crop plants such as potato, sugar beet, corn and small grains are also accepted herbaceous hosts. Campylomma bug feeds on the plant as well as preying on aphids and thrips while on the herbaceous host. Later in the season, adults move into to the orchard to mate and lay eggs. Other than the brief window around bloom when fruit damage can occur, campylomma bug is overwhelmingly a beneficial insect that helps manage aphids, mites, and psylla (important for pears) in the orchard. Monitoring populations early in the season is important for determining whether to apply treatments typically timed at prebloom or bloom (take precautions to protect pollinators). After this period, campylomma bug cannot damage fruit and serves as a beneficial insect. Operators may find that it is cost-effective to hand thin the fruit damaged in the early season.

Scouting and thresholds Nymphs and adults may be monitored by limb tapping from the pink stage through petal fall.

Management—cultural control

Early-blooming apple varieties may be most affected. Damaged fruit can be thinned.

Management—chemical control: HOME USE

There are no products specifically registered for control of campylomma bug in apple for home use.

Management—chemical control: COMMERCIAL USE

Stages 5-6: Pink spray

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A in up to 100 gal water per application. Do not apply when bees are active. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- esfenvalerate (Asana XL) at 4.8 to 14.5 oz/A in up to 100 gal water per application. REI 12 hr. PHI 21 days.
- thiamethoxam (Actara WDG) at 4.5 oz/A in a minimum of 50 gal water per application. Do not apply during bloom; highly toxic to bees. Do not exceed 16.5 oz/A per season. REI 12 hr. PHI 35 days. [Group 4A]

Apple—Cherry bark tortrix

Enarmonia formosana

Pest description and crop damage Cherry bark tortrix (CBT) damages many woody ornamental trees and shrubs in the family Rosaceae. In the PNW, this invasive moth occurs in urban settings in lowland coastal valleys in BC and Washington between the west slope of the Cascades and Puget Sound south to Portland. So far, it has not affected commercial fruit production regions. Oregon Department of Agriculture quarantine [603-052-0450] requires permits or certifications for importation of fruit tree nursery stock from BC, WA, and Multnomah and Clackamas Counties. Hosts for this pest include *Prunus* (cherry, plum, and peach), but also *Malus* (apple, crabapple), *Pyrus* (pear), *Crataegus* (hawthorn), *Sorbus* (mountain ash), *Cydonia* (quince), *Pyracantha* (firethorn), and *Photinia.* The quarantine also covers firewood from these trees.

The larvae are 0.3 to 0.4 inch long, pale gray to flesh-colored, with small, pale gray spines scattered on the surface and a yellowish-brown head. Larvae feed directly on the cambial tissues of the tree and may kill the tree in sufficient numbers. Otherwise, their feeding activity decreases the supply of nutrients to the tree and increases susceptibility to disease or insect attack and environmental stress, including cold injury. The first indication of attack is the exuding of a gum-like resin often mixed with fecal pellets and silk. The trunk and larger limbs of bearing fruit trees are affected, usually at pruning wounds.

Biology and life history Larvae overwinter under bark. During spring, they resume feeding and eventually pupate in a silken tube that protrudes beyond the bark surface of the feeding site. In Europe, pupation takes place from April until late August and lasts about two weeks. Adults fly from late April to September and are most active in the early morning; some may be attracted to lights at night.

Eggs are laid on tree bark, in crevices, or under loose bark, primarily at wounds (mechanical or old infestations). Eggs are placed singly or in overlapping groups of two or three and hatch in two to three weeks. Hatching larvae penetrate the bark through openings (natural and mechanical wounds) and feed on the living tissue of the tree's bark. Graft unions of ornamental trees are preferred sites for attack. Larvae do not penetrate the hardwood of the tree.

During feeding, larvae construct a frass tube consisting of fecal pellets and webbing. The tubes are about 0.25 inch long and look soft, as if they are made out of sawdust. They most often are found around the base of the trunk or where a branch and trunk meet. The frass tube is the location for pupation.

Scouting and thresholds Frass tubes protruding from bark are an excellent indication of CBT infestations, and susceptible trees should be monitored regularly. Because other insects can cause similar damage, inspection of the larvae is required for confirmation.

Management—biological control

Parasitoid wasps target the eggs, larvae, and pupae. Eggs that turn black indicate parasitism (likely by *Trichogramma* spp. wasps) and should not be disturbed.

Management—cultural control

Avoid unnecessary pruning cuts or injuries to the tree during the summer flight period. Like most wood-boring insects, this pest is attracted to stressed trees. Keep trees as healthy as possible with appropriate watering, fertilizer applications, and pruning. Reduce humidity around trunks by avoiding irrigation splash and control weeds and grass. Remove heavily infested branches or trees. Use pheromone traps to monitor male moth populations.

Management—chemical control: HOME USE

There are no products registered for control of this pest. Management activity should be concentrated in fall when biological controls have had a chance to act and larvae are still actively feeding and can be targeted.

Management—chemical control: COMMERCIAL USE

There are no products registered for control of this pest in commercial apple orchards because the pest, so far, has not been a significant issue in commercial orchards.

Apple—Codling moth

Cydia pomonella

Pest description and crop damage Codling moth is the most serious direct pest of apples in commercial and home orchards in the PNW. Wild populations are rampant in many areas of the PNW, and most apple varieties are heavily damaged without protection. The larvae bore into the fruit, often through the calyx or areas of contact between adjacent fruit. Larvae feed toward the core, leaving a characteristic tunnel filled with frass that often leads to fruit rotting. Larvae that die in the process of penetrating fruit can leave stings, which are shallow wounds in the fruit skin. In most regions of the PNW there are two damage periods; first the young fruitlets are attacked, and later the mature fruit.

Biology and life history Codling moth overwinter as mature larvae in silken cocoons (hybernacula) spun under loose bark, in the soil, or in litter at the base of the tree. Pupation takes place in the spring around the time the first blossoms are showing pink, and adults emerge around bloom of cv. 'Red Delicious'. There are typically two generations per year. Adults are mostly active at dusk and dawn and they can disperse over considerable distances. Females lay eggs on leaves and fruit.

Larvae wander to fruit and begin chewing through the skin and tunneling to the center of fruit to feed on the flesh and seeds. As they mature, they push frass out of the entry hole. After 3 to 4 weeks, the larvae leave the fruit to seek a sheltered spot on the tree or leaf litter to spin cocoons. Fruit infested by larvae may drop prematurely.

The larvae may overwinter in the cocoon, or they may emerge in 2 to 3 weeks as a new flight of adults. These adults are active in July and August. In areas that accumulate more heat units, there may even be a third generation. Larvae of this latter generation penetrate fruit but may not have enough time to complete development before harvest or the onset of winter.

Sampling and thresholds The development of codling moth can be predicted by the accumulation of heat units, or degree-days, using phenology models. By knowing the stage of the insect, we can target management to specific life stages that are susceptible. For codling moth, treatments against the eggs or the wandering larvae (during the brief period between egg hatch and the time when the larva is able to penetrate the fruit where it is protected) are the most effective. Phenology model recommendations can originate with your local Extension resource, crop consultant, software system, or use of an online degree-day calculator. It is important to make sure that you are using an appropriate tool/model for your region. Accurate weather data representing your orchard is very important. Homeowners can also benefit from use of degree-day models to predict management timing.

To calculate biofix for degree-day modeling, hang traps with 1 mg pheromone lures in the upper canopy in early spring (before blossoms reach pink stage). Biofix is the first capture of multiple male moths in a trap or consistent capture of multiple males over more than one trap. The biofix date is used as the point to start accumulating degree-days for the Brunner and Hoyt (1987) degree-day model, which is still the best model for PNW locations south of 46°N. North of this latitude, the no-biofix model can be used (Jones et al. 2008). It is important to note that the two models have different degree day accumulations for key events in the codling moth life cycle. The CM-DA lure contains a fruit odor and will catch females as well as males. Capture of females indicates potential for eggs and damage, but models can also use male captures for setting biofix. It is important to note that trap captures do not always reflect the potential for damage and the best approach for management is to integrate different strategies.

Management—biorational control

A number of commercial pheromone dispensers including hand applied dispensers and aerosol emitters are available to disrupt mating of codling moth. Apply pheromone dispensers or aerosol devices to the orchard well ahead of bloom. The codling moth population must already be at a low level for the technology to be effective. The orchard should be relatively large and without a high edge to core ratio. When mating disruption is used, monitor the orchard with pheromone traps baited with 1 mg lures to measure mating disruption effectiveness, and 10 mg pheromone or CM-DA lures set in the upper third of the canopy. If more than five male moths are captured in a trap over the first generation, check the orchard for fruit damage or apply a conventional insecticide. If fruit damage exceeds 0.5% at the end of the first generation, use conventional insecticides to provide supplemental control against the second generation. If more than two male moths are captured in a trap during the second generation, a conventional insecticide may be necessary.

Management—cultural control

Thinning fruit clusters to reduce the number of contact points between fruits may help reduce larval success rates for penetrating fruits. In small orchards, sanitation by removing and disposing of young, damaged fruit can be helpful in reducing codling moth. Check regularly throughout the

season for fruit with frass-filled holes. Removing and destroying infected fruit prior to larvae emergence preceding pupation can help reduce overall populations. Picking up dropped fruit from the ground likewise can be an effective sanitation measure. Homeowners can bag individual fruit (clusters thinned to one fruit) in paper or mesh bags approximately six weeks after bloom, however this can be labor-intensive and more challenging for cultivars with short stems. Fruit will mature completely within bags, however color development on red varieties may be affected. Homeowners can also place corrugated bands of cardboard around the lower trunk to attract larvae looking for a place to pupate. Place bands in May and remove before the adults begin to emerge in mid-June. The same technique can be used for the subsequent generation(s) later in summer.

Management—chemical control: HOME USE

After petal fall spray and spring and summer sprays

Apply first cover spray at 250 degree-days after biofix (or 225 degree-days if the selected insecticide has ovicidal activity), or about 10 days after full petal fall (all petals are off) or 17 to 21 days after full bloom. Insecticides are timed to target eggs and newly hatched larvae before they bore into the fruit. Multiple sprays are often necessary, but spray timing can be improved by monitoring for adult moths with pheromone-baited monitoring traps or use of degree-day models (see description above) to properly time insecticide applications to the hatching larvae during the growing season.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to pests. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- mating disruption pheromones—See biorational control above. Not a good option for small home orchard blocks, may increase damage.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees.
- spinosad (Entrust) —Some formulations OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—biorational control: COMMERCIAL USE ONLY

Stages 5-6: Pink application

Mating disruption. Pheromone release devices placed in the orchard interfere with the communication from female to male codling moth and this prevents or delays mating of moths, reducing the number of eggs laid and resultant crop damage. A number of hand-applied pheromone dispensers are available including Isomate C+, Isomate CTT, NoMate, CheckMate, Cidetrak CM, and Checkmate CM-XL 1000. These dispensers are typically applied to trees at densities of 200 to 400 per acre, sometimes with a higher density of dispensers applied to orchard borders. Research has shown that the most effective rate is 400 dispensers per acre. Aerosol devices for releasing pheromones are increasingly favored for their ease of application at densities of one device per acre. Substantial fruit damage could result from improper use of mating disruption, therefore follow the label recommendations. Blocks placed under mating disruption should be large, ideally greater than 10 acres, and prospects for success increase when neighboring orchards are also using the tactic and the codling moth pressure is already low. Pheromone dispensers can be most easily applied to dormant trees and must be in place before first moth flight around the time of full bloom of ‘Red Delicious’. Place within 2 ft of the top of the canopy. If the orchard has a history of codling moth problems, use one or more insecticide applications against the first generation. If a codling moth source exists nearby, use border sprays (five to six rows) of insecticides.

Management—biological (microbial) control: COMMERCIAL USE ONLY

- codling moth granulosis virus (Cyd-X, Virosoft CP4)—Check label for rates. REI 4 hr. PHI 0 day. Granulosis virus is a selective biological insecticide that must be ingested to be effective. Thorough coverage is important. The virus degrades when exposed to UV light. If a grower relies only on granulosis virus for codling moth control, frequent applications are necessary (every 7 to 10 days), especially when codling moth pressure is high. The virus controls larvae, but some fruit damage, primarily stings, may be evident. OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

After petal fall spray

Apply first cover spray at 250 degree-days after biofix, or earlier for ovicidal materials such as oil and growth regulators (225 degree-days). Note that many materials can be mixed with horticultural oil for increased activity against eggs and increased efficacy. This timing roughly corresponds to about 10 days after full petal fall (all petals are off) or 17 to 21 days after full bloom for ‘Red Delicious’. A second treatment is recommended approximately 14 days after the first (depending on residual) to cover the full period of moth egg laying in the first generation. The first summer generation spray should be applied at 1250 degree-days after biofix, and again a second treatment in 14 days will help cover the entire egg hatch period. Materials with rapid breakdown such as codling moth granulosis virus should be applied on a more frequent schedule.

- chlorantraniliprole (Altacor) at 3.0 to 4.5 oz/A in no less than 100 gal water per application. Do not apply more than 9 oz/A per growing season. Do not use an adjuvant within 60 days of harvest. REI 4 hr. PHI 5 days. [Group 28] [ovicidal and larvicidal]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. Apply just prior to egg hatch. REI 12 hr. PHI 3 days. [Group 28]
- horticultural mineral oil
- methoxyfenozide (Intrepid 2F) at 16 fl oz/A in up 100 gal water per application. For use against low- to moderate-pressure situations, with alternate control measures such as mating disruption. Use adjuvant; see label. Do not exceed 64 oz/A per growing season. REI 4 hr. PHI 14

days. [Group 18]

- novaluron (Rimon) at 30 to 50 fl oz/A in up to 100 gal water per application with a second application 14 to 17 days later. Do not apply more than 150 fl oz per growing season. REI 12 hr. PHI 14 days. [Group 15]
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications per season. Do not apply earlier than 14 days after last Esteem 35 WP treatment. REI 12 hr. PHI 45 days. [Group 7C]

Spring and summer

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. Adding a low rate of horticultural mineral oil improves effectiveness against codling moth. REI 12 hr. PHI 7 days. [Group 4A] [ovicidal and larvicidal]
- *Chromobacterium subtsugae* (Grandevo) at 1 to 3 lb/A. Under heavy pest populations, apply a knockdown insecticide prior to or in a tank mix, use the higher label rates, shorten the spray interval, and/or increase the spray volume to improve coverage. REI 4 hr. PHI 0 day. OMRI-listed for organic use.
- clothianidin (Belay) at 6 fl oz/A. For control of first generation codling moth in areas with light pressure and suppression of first generation codling moth in areas of heavy infestation. Do not apply more than 12 fl oz of Belay per acre per season. REI 12 hr. PHI 7 days. Do not feed or allow livestock to graze on cover crops from treated orchards. Belay must not be applied during bloom or if bees are actively foraging. [Larvicidal].[Group 4A]
- chlorantraniliprole (Altacor) at 3.0 to 4.5 oz product/A in no less than 100 gal water per application. Do not apply more than 9 oz per acre per growing season. Do not use an adjuvant within 60 days of harvest. REI 4 hr. PHI 5 days. [Group 28] [ovicidal and larvicidal]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. Apply just prior to egg hatch. REI 12 hr. PHI 3 days. [Group 28]
- emamectin benzoate (Proclaim 5SG) at 3.2 to 4.8 oz/A in up to 100 gal water per application. For use in low to moderate pressure situations with alternate control measures such as mating disruption. Do not exceed 14.4 oz/A per season. REI 12 hr (48 hr for workers performing propping, pruning, thinning and tying). PHI 14 days. [Group 6] [larvicidal]
- fenpropathrin (Danitol 2.4 EC) at 16 to 21.3 fl oz/A in up to 100 gal water per application. Will also reduce mite populations but may cause resurgence the same season. Do not exceed 42.7 fl oz per acre per season. REI 24 hr. PHI 14 days. [Group 3]
- granulosis virus (CYD-X, CYD-X HP, Virosoft CP4)— Check label for rates. Start at the beginning of first generation egg hatch. Apply every 7 to 10 days. REI 4 hr. PHI 0 day. [larvicidal] OMRI-listed for organic use.
- indoxacarb (Avaunt) at 5 to 6 oz/A in up to 200 gal water per application. Make no more than three applications prior to hand-thinning. No hand thinning after the fourth application. Make no more than four applications per growing season. Do not apply more than 24 oz/A per growing season. For use in low- to moderate-pressure situations, with alternate control measures such as mating disruption. REI 12 hr. PHI 14 days. [Group 22]
- methoxyfenozide (Intrepid 2F) at 16 fl oz/A in up to 100 gal water per application. For use against low- to moderate-pressure situations, with alternate control measures such as mating disruption. Do not exceed 64 oz/A per season. REI 4 hr. PHI 14 days. [Group 18] [ovicidal and larvicidal]
- novaluron (Rimon) at 30 to 50 fl oz/A in up to 100 gal water per application. See label for application timing. Do not exceed 150 fl oz/A per season. REI 12 hr. PHI 14 days. [Group 15] [ovicidal]
- phosmet (Imidan 70W) at 2.1 to 5.7 lb/A in up to 100 gal water per application. REI/PHI 7 days. [Group 1B]
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications per growing season. REI 12 hr. PHI 45 days. [Group 7C] [ovicidal]
- spinetoram (Delegate WG) at 6 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per season. REI 4 hr. PHI 7 days. [Group 5] [larvicidal]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz/A per season. REI 4 hr. PHI 7 days. OMRI-listed for organic use. [Group 5] larvicidal]
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A in up to 100 gal water per application. Do not apply exceed 16 oz/A per season and do not use an adjuvant within 60 days of harvest. REI 12 hr. PHI 35 days. [Group 4A & 28] [ovicidal and larvicidal]

Apple–Eyespotted bud moth

Spilonota ocellana

Pest description and crop damage Adults are grayish moths about 0.4 inch long with a wide white band on each forewing. Larvae are chocolate-brown with black heads, and up to 1 inch long. The eyespotted bud moth does not usually require control on apples.

Biology and life history Larvae spend the winter in a cocoon on the bark in the crotches of small-diameter limbs. They become active around budbreak and feed on leaves and buds, webbing together leaves and feeding within these nests. After feeding, they pupate within the nest and adult moths emerge in early to mid-summer. Eggs are laid on the lower surface of leaves. The larvae emerge and feed on the lower leaf surface until early August, at which time they construct their overwintering cocoons (hibernacula).

Sampling and thresholds Look for larvae in nests of webbed-together leaves in the spring.

Management—chemical control: HOME USE (note: treatments rarely necessary)

Spring and summer

- carbaryl—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE (note: treatments rarely necessary)

Spring and summer

- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A in up 100 gal water per application. Apply once or twice against overwintering larvae. Do not exceed 64 fl oz/A per growing season. REI 4 hr. PHI 14 days. [Group 18]
- novaluron (Rimon) at 20 to 40 fl oz/A in 100 gal water per application. Apply at beginning of egg hatch. Do not use Rimon in alternate row middle application patterns since this method will result in off-timing application and poor performance. Do not apply more than four applications or more than 150 fl oz/A per growing season. Do not allow Rimon to drift on grapes as leaf spotting may occur. REI 12 hr. PHI 14 days. [Group 15] [ovicide]
- tebufenozide (Confirm 2F) at 20 fl oz/A in up to 100 gal water per application. Do not apply more than 120 fl oz/A per growing season. REI 4 hr. PHI 14 days. [Group 18A]

Apple—Flatheaded borers

Includes
Pacific flatheaded borer (*Chrysobothris mali*)
Flatheaded apple tree borer (*Chrysobothris femorata*)

Pest description and crop damage These flatheaded borers are pests of many different trees and shrubs, including most fruit trees. Adults are metallic, oval and flattened. Flatheaded apple tree borer are a greenish bronze color and are the larger species, with adults typically measuring 0.35 to 0.63 inches. Pacific flatheaded borers are typically the more destructive species in the PNW, and adults are reddish-bronze beetles with copper-colored spots on wing covers, and are about 0.25 to 0.5 inch long. Larvae of both species are legless, whitish to pale yellow and about 0.5 inch long when fully developed. Just behind the head is a broad, flat enlargement giving a "flat-headed" appearance. Larvae feed beneath the bark and may girdle the trunks and branches of trees. Young, recently planted trees can be very susceptible to girdling by these pests. Trees that are stressed because of drought or suffering sunburn or sun scald on the trunks are particularly susceptible to attack. Apple trees are sometimes attacked at the graft union.

Biology and life history The insects overwinter in host plants as mature larvae. In spring, they pupate and then bore "D" shaped emergence holes in the tree. Some borers may spend more than one season in tree trunks. They emerge usually from late May through August. Females lay eggs from June through July in crevices in the bark, usually on the sunny side of tree trunks below the lowest branches. Stressed trees are the preferred egg-laying site. The larvae hatch, burrow into the wood, and feed on the cambial and vascular tissues until full grown. Burrows are characteristically broad and irregular.

Scouting and thresholds Watch for swellings under bark on young trees or cracks through which frass may be seen. Fine sawdust frass piles may be evident around the base of infested trees.

Management—biological control

Birds peck the larvae from under the bark with their beaks. Some wasp parasites attack the borer. Carpenter ants eat both larvae and pupae from the wood. Harvest mites attack pupae inside the pupal chambers.

Management—cultural control

Beetles are attracted to weakened, sunburned, or injured parts of the trunk and lay eggs in cracks on bark exposed to the sun. Protect young and newly planted trees from sunburn by whitewashing or painting with white interior latex paint. Paper trunk protectors or shading the trunk with boards also may be helpful. Avoid drought stress and nutrition deficiency on young trees. Remove infested trees where practical to reduce pest pressure.

June through July sprays

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Management strategies include use of trunk sprays or systemic materials.

- fenpropathrin (Danitol 2.4 EC) at 16 to 21.3 fl oz/A in up to 100 gal water per application. Do not exceed 42.7 fl oz/A per season. Highly toxic to fish, bees, and wildlife. REI 24 hr. PHI 14 days. [Group 3A]
- imidacloprid (Admire Pro and generics) at 7 to 10.5 fl oz/A chemigation or root drench, depending on label. Do not apply prior to bloom or when bees are actively foraging. Do not apply more than 10.5 oz product/A per growing season. REI 12 hr. PHI 21 days.

Apple—Grape mealybug

Pseudococcus maritimus

Pest description and crop damage The nymphs (or crawlers) are purplish and covered with a powdery wax coating. As they get older, the coating gets thicker, and a fringe of wax filaments develops. The adult female is wingless and looks similar to a nymph. It can be up to 0.1875 (3/16) inch long. It has a well-developed ring of waxy filaments around the sides of its body. Mealybugs cause damage by secreting honeydew. Honeydew is cast off in small drops and falls down through the canopy. When it lands on fruit it causes a coarse black russet, which is similar to pear psylla russeting. However, mealybug russeting is scattered over the fruit surface, while honeydew from psylla is in patches or streaks.

Biology and life history Grape mealybug overwinter as crawlers in egg sacs beneath bark scales and in cracks. Crawlers start emerging from egg sacs at the beginning of bud swell and begin feeding on the base of buds. When buds open, the crawlers go directly to new shoots and leaves. Once settled, the crawlers start feeding and become progressively harder to kill. First generation nymphs mature during late June and July in the Pacific Northwest. Winged adult males appear first, mate with last instar nymphs or adult females and die. Receptive females release a pheromone to attract males. Mated females migrate to sheltered areas, lay eggs and die in the egg sac. A partial second generation matures in late August and September. Nymphs of this generation sometimes settle in or around the fruit calyx.

Management—biological control

Little research has been done to date on the effectiveness of natural enemies in keeping mealybug populations at levels below economic damage. Parasitic wasps, predatory bugs, predatory beetles, lacewings, and spiders can take a considerable toll on mealybugs. A lady beetle, the "mealybug destroyer" (*Cryptolaemus montrouzieri*), is considered an effective predator of mealybugs worldwide. It is available from some insectaries.

Management—chemical control: HOME USE

Stages 5-6: Pink spray, spring and summer

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Stages 5-6: Pink spray

- buprofezin (Centaur WDG) at 34.5 oz/A as a ground application using a minimum of 20 gal water per acre. Do not make more than one application per growing season. REI 12 hr. [Group 16]
- diazinon (Diazinon 50W) 2 to 4 lb/A in up to 100 gal water per application. Dormant or delayed dormant use of diazinon is limited to one application per season. REI 4 days. [Group 1B]

Spring and summer

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days.[Group 4A]
- buprofezin (Centaur WDG) at 34.5 oz/A as a ground application using a minimum of 20 gal water per acre. Do not make more than one application per growing season. REI 12 hr. PHI 14 days. [Group 16]
- *Chromobacterium subtsugae (*Grandevo) at 2 to 3 lb/A. Under heavy pest populations, apply a knockdown insecticide prior to or in a tank mix, use the higher label rates, shorten the spray interval, and/or increase the spray volume to improve coverage. REI 4 hr. PHI 0 day. OMRI-listed for organic use.
- diazinon (Diazinon 50W) at 4 lb/A in up to 100 gal water per application. Do not apply more than one in-season application per season. REI 4 days. PHI 21 days. [Group 1B]

Apple—Green fruitworm

Includes
Green fruitworm (*Lithophane antennata*)
Pyramidal fruitworm (*Amphipyra pyramidioides*)

Pest description and crop damage Several species of green fruitworms can attack fruit trees. Fruitworms are found feeding on a wide range of hosts such as willow, birch, alder, maple, and other tree fruits. Adult fruitworm moths vary depending on the species but are generally large, with gray to reddish-brown wings, and are attracted to lights in the fall and spring. Immature larvae are similar to cutworms, with green bodies and heads. Mature larvae are green with white or cream longitudinal stripes.

Green fruitworm larvae feed on flowers and leaves, occasionally tying them together with silk. When the larvae increase in size, they begin feeding on the fruit, starting inside the cluster and taking bites out of most fruit in the cluster. Badly damaged fruits drop, and damaged fruits that remain have large, russeted cavities.

Biology and life history Depending on species, the insect may overwinter as a pupa in the ground or as a fertilized female moth on the soil surface. In the spring, eggs are laid on the twigs, often before buds open. The eggs hatch at the pink stage. Young larvae feed on the flowers and leaves, and later on the leaves and fruit. When the larvae mature, they drop to the soil to pupate. Depending on species, they remain as pupae through the winter or emerge as adults in fall, mate, and the females overwinter.

Scouting and thresholds Examine fruit clusters shortly after fruit set for the small green larvae. They tend to occur in clumps, so thorough monitoring is required.

Management—biological control

Birds often are seen eating green fruitworm larvae. Ground predators probably reduce pupal or adult overwintering populations. Some parasitic wasps are also important.

Management—cultural control

Adults can be collected in black-light traps. Hand-pick larvae when thinning fruit.

Management—chemical control: HOME USE

Stages 5-6: Pink spray

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

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 5-6: Pink spray

- *Bacillus thuringiensis* var. *kurstaki* (*Btk*) (Dipel, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* materials two to three times, beginning at prepink, repeating at pink and petal fall. Apply *Btk* when temperature exceeds 60°F. REI 4 hr. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. REI 12 hr. PHI 3 days. [Group 28]

Apple—Lacanobia fruitworm

Lacanobia subjuncta

Pest description and crop damage Also known as speckled cutworm moth, the adult is about 1 inch long and has a distinctive color pattern of scales on the wing that range from light brown to black. The appearance of the larva varies with age: young larvae resemble green fruitworms (green with a lateral stripe), while older larvae may be bright green to tan to a light red or brick color. Mature larvae have a herringbone pattern on the dorsal side and may be up to 2 inches long.

Larvae can defoliate shoots. Older larvae also feed on the fruit. Typically, the feeding damage resembles a small scoop removed from the fruit.

Biology and life history The insect overwinters as a pupa in the soil and adults emerge in May and June. Eggs may be deposited in fruit trees or on weed hosts. The first-generation larvae appear in June and July and feed principally on foliage, but may also feed on fruit. Larvae are voracious feeders and can defoliate shoots in a few days. The emergence of second-generation adults begins in late July and they are active through October. Larval feeding from the second generation begins in mid-August and larvae can be found in October.

Scouting and thresholds Examine fruit clusters shortly after fruit set for the small green larvae. They tend to occur in clumps, so thorough monitoring is required.

Management—cultural control

Home orchardists: Adults can be collected in black-light traps. Hand-pick larvae when thinning fruit.

Management—chemical control: HOME USE

Spring and summer

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer

- chlorantraniliprole (Altacor) at 3.0 to 4.5 oz product/A in no less than 100 gal water per application. Do not apply more than 9 oz per acre per growing season. Do not use an adjuvant within 60 days of harvest. REI 4 hr. PHI 5 days. [Group 28] [ovicidal and larvicidal]
- emamectin benzoate (Proclaim 5SG) at 3.2 to 4.8 oz/A in up to 100 gal water per application. Do not exceed 14.4 oz/A per growing season. REI 12 hr (48 hr for workers performing propping, pruning, thinning and tying). PHI 14 days. [Group 6].
- indoxacarb (Avaunt) at 3 to 6 oz/A in up to 100 gal water per application. Make no more than three applications prior to hand-thinning. No hand thinning after the fourth application. Make no more than four applications per growing season. Do not apply more than 24 oz/A per growing season. Apply in spray volume of up to 200 gal/A. REI 12 hr. PHI 14 days. [Group 22]
- novaluron (Rimon) at 20 to 50 fl oz/A in 100 gal water per application. Apply when lacanobia eggs have hatched and larvae are in first to third instar range. Do not use Rimon in alternate row middle application patterns since this method will result in off-timing application and poor performance. Do not apply more than four applications or more than 150 fl oz/A per growing season. Do not allow Rimon to drift on grapes as leaf spotting may occur. REI 12 hr. PHI 14 days. [Group 15] [ovicide]
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per growing season. REI 4 hr. PHI 7 days. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz /A per season. REI 4 hr. PHI 7 days. [Group 5] OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 10 to 20 oz/A in up to 100 gal water per application. Do not apply more than 120 oz/A per growing season. REI 4 hr. PHI 14 days. [Group 18A]

Apple—Leafhopper

Apple leafhopper (*Kyboasca maligna*)
Rose leafhopper (*Edwardsiana rosae*)
White apple leafhopper (*Zonocyba pomaria*)

Pest description and crop damage Multiple leafhopper species are found throughout the PNW. The most prevalent leafhopper in Washington is the white apple leafhopper, although a very similar-appearing insect, the rose leafhopper, is also present. Rose leafhopper nymphs are very similar to white apple leafhopper, but they have rows of black spots on the back. Adults and nymphs suck juices from leaves, causing stippling and mottling on leaves. Damage usually is most noticeable on neglected trees. In general, this pest is a minor problem, and even high populations rarely cause yield loss.

Biology and life history These insects overwinter as eggs just beneath the bark on 1- to 5-year-old twigs in the trees. Presence of the eggs is indicated by characteristic crescent-shape swellings in the bark. Eggs hatch around the tight cluster stage (late March to mid-April), and nymphs feed for several weeks. Adults are flying by late May and can be observed from then until frost, when they are killed. Overwintering eggs are laid in September. There are two generations per year.

Scouting and thresholds As a minor pest, monitoring is not necessary, although presence of the adults can be confirmed by early morning limb taps.

Management—biological control

Parasitic wasps exert some control over leafhopper populations.

Management—chemical control: HOME USE

Petal fall spray and Spring/ Summer

Best time to control the first generation is petal fall or shortly thereafter. Apply about 10 days after full petal fall (all petals are off) or 17 to 21 days after full bloom.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Petal fall spray

- acetamiprid (Assail 70WP) at 1.1 to 1.7 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- buprofezin (Centaur WDG) at 34.5 oz/A as a ground application using a minimum of 20 gallons of water per acre. Do not make more than one application per growing season. REI 12 hr. PHI 14 days. [Group 16]
- fenpyroximate (Fujimite 5SC) at 2 pints/A in a minimum of 100 gal water per acre. Only one application per season. Do not apply through any type of irrigation system. Do not apply by alternate row middle spray method. REI 12 hr. PHI 14 days. [Group 21A]
- imidacloprid (Prey 1.6F) at 4 to 8 fl oz/A in up to 100 gal water per application. Do not use within 10 days prior to bloom or when bees are actively foraging. Allow 10 days between applications. Do not apply more than 40 fl oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- insecticidal soap (M-Pede) at 1 gal/100 gal water (up to 4 gal/A in 400 gal water per acre per application). REI 12 hr. PHI 0 day. M-Pede can be phytotoxic. Some formulations are OMRI-listed for organic use.
- kaolin (Surround WP) at 25 to 50 lb/A applied as a spray to leaves, stems, and fruit. Continue applications every 7 to 14 days to assure adequate coverage on newly growing plant surfaces. Kaolin acts as a repellant to target pests. REI 4 hr. PHI 0 days.
- novaluron (Rimon) at 20 to 50 fl oz/A in 100 gal water per application. Do not use Rimon in alternate row middle application patterns since this method will result in off-timing application and poor performance. Do not apply more than 150 fl oz/A per growing season. Do not allow Rimon to drift on grapes as leaf spotting may occur. REI 12 hr. PHI 14 days. [Group 15]
- thiamethoxam (Actara WDG) at 2 to 2.75 oz/A in up to 100 gal water per application. Do not exceed 16.5 oz/A per season. Actara is extremely toxic to bees. REI 12 hr. At rates less than 2.75 oz/A, the PHI is 14 days. [Group 4A]

Spring and summer

- acetamiprid (Assail 70WP) at 1.1 to 1.7 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- clothianidin (Belay) at 4 to 6 fl oz/A in up to 100 gal water per application. Do not apply more than 12 fl oz/A per growing season. REI 12 hr. PHI 7 days. [Group 4A]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. REI 12 hr. PHI 3 days. [Group 28]
- imidacloprid (Admire Pro) at 7 to 10.5 fl oz/A in up to 100 gal water per application as a soil application. Do not apply prior to bloom or when bees are actively foraging. Do not apply more than 10.5 fl oz product/A per growing season. REI 12 hr. PHI 21 days. [Group 4A]
- indoxacarb (Avaunt) at 5.0 to 6.0 oz/A in up to 100 gal water per application. Make no more than 3 applications prior to hand-thinning. No hand thinning after the 4th application. Make no more than 4 applications per growing season. Do not apply more than 24 oz product per acre per growing season. REI 12 hr. PHI 14 days. [Group 22A]
- insecticidal soap (M-Pede) at 1 gal/100 gal water (up to 4 gal/A in 400 gal water per acre per application). REI 12 hr. PHI 0 day. Some formulations are OMRI-listed for organic use.
- kaolin (Surround WP) at 25 to 50 lb/A applied as a spray to leaves, stems, and fruit. Continue applications every 7 to 14 days to assure adequate coverage on newly growing plant surfaces. Kaolin acts as a repellant to target pests. REI 4 hrs. PHI 0 days. Some formulations are OMRI-listed for organic use.
- sulfoxaflor (Transform WG) at 0.75 to 1.5 oz/A in up to 100 gal water per application. See supplemental label. No more than four applications per season. PHI 7 days [Group 4C]
- thiamethoxam (Actara WDG) 2 to 2.75 oz/A in up to 100 gal water per application. Do not exceed 16.5 oz /A per season. Actara is extremely toxic to bees. REI 12 hr. At rates less than 2.75oz/A, the PHI is 14 days. [Group 4A]
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A in up to 100 gal water per application. Do not apply exceed 16 oz of product/A per season and do not use an adjuvant within 60 days of harvest. REI 12 hr. PHI 35 days. [Group 4A & 28]

Apple—Leafminer

Western tentiform leafminer (*Phyllonorycter elmaella*)

Pest description and crop damage Adult moths are about 0.12 inch long. The wings are held roof-like over the body and are golden bronze with white bands. The larvae vary in appearance depending on their age, as they progress through five instars. Young larvae are legless and cream-colored. Older instars have legs and are cylindrical in shape, cream-colored and about 0.125 inch long. Mature larvae are yellow and about 0.167 inch long. The larvae feed within the leaf tissue creating dead discolored areas on leaves. If feeding is extensive, fruit quality and yield may be affected.

Biology and life history This insect overwinters as pupae in leaf litter. The adults emerge early in the season and lay eggs on the undersides of leaves around the pink stage of flower bud development. Eggs are flat and translucent. The first three larval instars feed on spongy soft tissue inside the leaves, creating blotches visible only on the underside. By early to mid-May larvae begin to feed on the upper surface of the leaf beneath the epidermis, spinning silken webs to tie the mine together, giving it the characteristic “tentiform” appearance. Larvae of the first generation then pupate in the leaf. There are three to four overlapping generations per year.

Sampling and thresholds An average of three eggs per leaf is the proposed action threshold.

Management—biological control

A small parasitic wasp, *Pnigalio flavipes,* provides sufficient control that insecticides are rarely required. Leafminer problems may be induced by loss of biological control due to broad spectrum insecticides.

Management—chemical control: HOME USE

Stages 3-4: Prepink & tight cluster sprays

If required, sprays should be timed after the eggs of a generation have hatched, but before tissue-feeding larvae (the oldest larval stages) are observed.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl —Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 3-4: Prepink & tight cluster sprays

Treatment at this timing may create mite problems. It is best to wait until the second generation appears before electing to spray.

- abamectin (Abamex) at 10 to 20 oz/A in up to 100 gal water per application. For best effect apply against egg and early sap feeder stages of first and second generation. Do not apply during bloom. Do not apply more than two applications per growing season. Best used early in the season (before June 15); control after that may be unsatisfactory. Do not use within 14 days before or after Captan. Use with an adjuvant. May cause russeting on light-skinned varieties (e.g., 'Golden Delicious'). REI 12 hr. [Group 6]
- acetamiprid (Assail 70WP) at 1.1 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. REI 12 hr. [Group 4A]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. REI 12 hr. PHI 3 days. [Group 28]
- novaluron (Rimon) at 15 to 40 fl oz/A in 100 gal water per application. Monitor moth flights and time treatment to eggs. Do not use Rimon in alternate row middle application patterns since this method will result in off-timing application and poor performance. Do not apply more than four applications or more than 150 fl oz/A per growing season. Do not allow Rimon to drift on grapes as leaf spotting may occur. REI 12 hr. PHI 14 days. [Group 15] [ovicide]
- pyriproxyfen (Esteem 35WP) at 3 to 5 oz/A in up to 100 gal water per application. Provides suppression when applied as part of a season-long program. Do not exceed two applications per growing season. REI 12 hr. [Group 7C]
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per growing season. REI 4 hr. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz /A per season. REI 4 hr. [Group 5] larvicidal] OMRI-listed for organic use.

Apple—Leafroller

Includes
European or filbert leafroller (*Archips rosana*)
Fruittree leafroller (*Archips argyrospila*)
Obliquebanded leafroller (*Choristoneura rosceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage Several species of leafrollers [family: Tortricidae] are pests of tree fruits. These species use native host plants as well as fruit trees. The different species of leafroller cause similar damage to apple trees but differ in appearance and life cycle. The principal leafroller pests of fruit trees are divided into single-generation moths, such as the fruittree leafroller and the European leafroller, and two-generation moths, such as the obliquebanded leafroller and pandemis leafroller. Adults of these species vary from fawn-color to dark brown. There are distinctive bands or mottling on the wings. Wingspans range from 0.5 to 1 inch. The larvae of these species are all green caterpillars with a light brown to black head, depending on the species. Pandemis larvae are green with a green or brown head. Obliquebanded leafroller larvae are similar to pandemis larvae, except the head is dark brown to black.

As the name leafroller implies, the larvae roll and tie leaves together for shelter and feeding. They thrash about violently when disturbed and may drop from the leaf suspended by a silken thread. Feeding on growing points on young plants can promote undesirable branching. Prebloom leafroller feeding within the cluster results in fruit abortion or deeply scarred fruit. Young larvae are tiny and notoriously difficult to sample, but they are typically most damaging because of feeding on developing fruitlets. The later life stages are evident as the caterpillars reach maximum size and the number of damaged leaves increases. Mature leafroller larvae often move to a new leaf just prior to pupation. By this point, any damage to fruit is complete and it is better to allow natural enemies to reproduce on the mature larvae than to attempt treating the population.

Biology and life history The single-generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring as buds are opening until petal fall. The larvae feed for 4 to 6 weeks, then pupate in the rolled leaves and emerge as moths in early summer. The overwintering eggs are laid in July.

Two-generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants. Larvae may feed during warm periods in winter but become active in spring with onset of new growth. They feed for several weeks, first on buds then leaves before they pupate in rolled leaves. Adult moths emerge in late April to May. These lay eggs for the next generation. The next generation hatches in early summer and does the most damage.

Scouting and thresholds Scouting for young larvae is challenging, but mature larvae are readily apparent. Populations can be detected early in the season by opening buds around bud break to examine for silk, frass, and minute larvae using magnification. Observe early spring growth for rolled leaves and feeding damage on new growth.

Management—biological control

Very low temperatures in winter significantly reduce overwintering populations of larvae. Spiders and parasitic wasps, as well as predators like the brown lacewing, greatly reduce leafroller populations throughout the year. Parasitism is particularly intense on mature larvae just prior to pupation, a time when insecticide treatments are not effective against leafrollers, but have a strong negative effect on the natural enemy community. A large complex of predators, parasitoid wasps, and parasitoid flies (Tachinidae) attack leafroller larvae.

Management—cultural control

Fruit thinning can reduce problems significantly with some leafrollers. Thin fruit clusters to a single fruit. Hand-pick rolled leaves containing larvae or pupae.

Management—chemical control: HOME USE

Stages 2-3: Delayed-dormant spray

Apply sprays during dormant or delayed-dormant period (March to April). Do not use after pink appears in buds. Use enough water to cover all of the tree thoroughly including small limbs and shoots.

- horticultural mineral oil

Stages 3-4: Prepink & tight cluster sprays, Stages 5-6: Pink spray, and petal fall

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use. —Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 2-3: Delayed-dormant spray

- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 400 gal water. Do not exceed two applications per season. Do not apply earlier than 14 days after last Esteem 35 WP IGR treatment. REI 12 hr. [Group 7C]

Stages 3-4: Prepink & tight cluster sprays

- *Bacillus thuringiensis* var. *kurstaki* (*Btk*) (Dipel DF, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* materials two to three times, beginning at prepink, repeating at pink and petal fall. Apply *Btk* only when temperature exceeds 60°F. REI 4 hr. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A in up 100 gal water per application. Apply once or twice against overwintering larvae. Do not exceed 64 fl oz/A per growing season. REI 4 hr. [Group 18]
- peptide GS-omega/kappa-Hxtx-Hv1a (Spear-Lep) at 1 to 2 pints/A. Biological insecticide that should be tank mixed with equal parts of *Bt*. PHI 0 days. REI 4 hr.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications growing season. REI 4 hr. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz /A per season. REI 4 hr. [Group 5] larvicidal] OMRI-listed for organic use.

Stages 5-6: Pink spray

- *Bacillus thuringiensis* var. *kurstaki* (*Btk*) (Dipel, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* materials two to three times, beginning at prepink, repeating at pink and petal fall. Apply *Btk* when temperature exceeds 60°F. REI 4 hr. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]
- fenpropathrin (Danitol 2.4 EC) at 16 fl oz/A in up to 100 gal per application. Do not exceed 42.7 fl oz/A per season. REI 24 hr. [Group 3]
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A in up to 100 gal water per application. Apply once or twice against overwintering larvae. Use adjuvant. Do not exceed 64 fl oz/A. REI 4 hr. [Group 18]
- peptide GS-omega/kappa-Hxtx-Hv1a (Spear-Lep) at 1 to 2 pints/A. Biological insecticide that should be tank mixed with equal parts of *Bt.* PHI 0 days. REI 4 hr.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications per growing season. REI 12 hr. [Group 7C]
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per growing season. REI 4 hr. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz/A in up to 100 gal water per application. Do not exceed three applications or 9 oz/A per growing season. REI 4 hr. [Group 5] OMRI-listed for organic use.

Petal fall

- *Bacillus thuringiensis* var. *kurstaki* (*Btk)* (Dipel, Javelin, etc.)—Formulations vary; see label for rates. Apply *Btk* materials two to three times, beginning at prepink, repeating at pink and petal fall. Apply *Btk* when temperature exceeds 60°F. REI/PHI 4 hr. Some formulations are OMRI-listed for organic use. [Group 11] [larvicide]
- chloranthraniliprole (Altacor) at 2.5 to 4.5 oz/A in no less than 100 gal water per application. Do not apply more than 9 oz/A per growing season. Do not use an adjuvant within 60 days of harvest. REI 4 hr. PHI 5 days. [Group 28] [ovicide]
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A in up to 100 gal water per application. For overwintering leafroller larvae, apply at pink to petal fall. For summer generations apply ahead of egg hatch. REI 12 hr. PHI 3 days. [Group 28]
- Chromobacterium subtsugae (Grandevo) at 1 to 3 lb/A. Under heavy pest populations, apply a knockdown insecticide prior to or in a tank

mix, use the higher label rates, shorten the spray interval, and/or increase the spray volume to improve coverage. REI 4 hr. PHI 0 day. OMRI-listed for organic use.

- emamectin benzoate (Proclaim 5SG) at 3.2 to 4.8 oz/A in up to 100 gal water per application. Do not exceed 14.4 oz/A per season. REI 12 hr (48 hr for workers performing propping, pruning, thinning and tying). PHI 14 days. [Group 6] [larvicide].
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A in up to 100 gal water per application. Apply once or twice against overwintering larvae. Use adjuvant; see label. Do not exceed 64 fl oz/A per season. REI 4 hr. PHI 14 days. [Group 18] [ovicide]
- novaluron (Rimon) at 30 to 50 fl oz/A in 100 gal water per application. Do not use Rimon in alternate row middle application patterns since this method will result in off-timing application and poor performance. Do not apply more than four applications or more than 150 fl oz/A per growing season. Do not allow Rimon to drift on grapes as leaf spotting may occur. REI 12 hr. PHI 14 days. [Group 15] [ovicide]
- peptide GS-omega/kappa-Hxtx-Hv1a (Spear-Lep) at 1 to 2 pints/A. Biological insecticide that should be tank mixed with equal parts of Bt. PHI 0 days. REI 4 hr.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications per growing season. REI 12 hr. PHI 45 days. [Group 7C]
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per growing season. REI 4 hr. PHI 7 days. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz/A in up to 100 gal water per application. Do not exceed three applications or 9 oz/A per growing season. REI 4 hr. PHI 7 days [Group 5] [larvicide] OMRI-listed.

Resistance management Leafrollers can develop resistance rapidly to chemical controls. Alternate chemistries and modes of action.

Apple—Lesser appleworm

Grapholita prunivora

Pest description and crop damage This is a tortricid pest similar in habits to oriental fruit moth. The larvae feed inside the fruit, often entering through the calyx end. Lesser appleworm is not currently a problem in commercial orchards, despite being distributed throughout the fruit producing regions of the PNW. It is a moth native to the northeastern US that was first discovered in the PNW in the 1940s.

Biology and life history The lesser appleworm prefers host plants in the rose family, including crabapples, hawthorn, wild rose and others.

It overwinters as a mature larva at the base of host plants or under bark scales. The adults begin to emerge in April, and females lay eggs on leaves or the fruit surface. The larvae feed on the fruit for about three weeks, then pupate at the base of the tree or under bark scales. Second-generation adults appear in late spring. These also lay eggs on the fruit. Late in the season, mature larvae spin cocoons to overwinter.

Management—chemical control: HOME USE

- acetamiprid
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Insecticides used for codling moth are probably effective. Lesser appleworm is not a problem in orchards receiving a regular spray program.

Apple—Lygus bug

Includes
Pale legume bug (*Lygus elisus*)
Tarnished plant bug (*Lygus lineolaris*)
Western tarnished plant bug (*Lygus hesperus*)

Pest description and crop damage Adult lygus bugs are oval, about 0.19 inch long with a light yellow 'V' on the back. There are three species that attack tree fruits and the body color may be green or brown. The bugs feed on developing leaves, flowers and fruit. Most fruit damage occurs shortly after bloom on fruitlets. Dimpling and deep pitting of fruit are indications of early feeding damage. Cat-facing damage is a fruit deformity that occurs when cells surrounding the dead cells at the feeding site continue to grow as the fruit matures, resulting in severely misshapen fruit.

Biology and life history These insects overwinter as adults in protected areas such as leaf debris, in bark cracks or similar spaces. Adults become active in early spring, feeding on buds of trees and shrubs before moving to other plants. Eggs are laid in the stems and other tissues of host plants. There may be several generations per year.

Management—cultural control

Eliminate weeds that serve as protection and early season food for the insect. Lygus problems are most likely to occur with alfalfa or unmanaged borders. Eliminate border habitat or target management on border rows. Hand-thin damaged fruit.

Spring and summer

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. Will provide suppression. Do not apply during bloom. REI 12 hr. PHI 7 days. [Group 4A]
- flonicamid (Beleaf 50 SG) at 2.0 to 2.8 oz of product/A in up to 100 gal water per application. Do not apply more than three applications per season. REI 12 hr. PHI 21 days. [Group 29]
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz in enough water to achieve thorough coverage. REI 24 hr. PHI 21 days. [Group 3]
- thiamethoxam (Actara WDG) at 4.5 to 5.5 oz/A in up to 100 gal water per application. Do not exceed 16.5 oz/A per season. REI 12 hr. PHI 35 days. [Group 4A]
- zeta-cypermethrin (Mustang Maxx) at 1.28 to 4.0 fl oz/A in a minimum of 100 gal water for dilute spray. REI 12 hr. PHI 14 days. [Group 3A]

Apple—Scale

Includes
Oystershell scale (*Lepidosaphes ulmi*)
San Jose scale (*Comstockaspis perniciosa*)

Pest description and crop damage San Jose scale was introduced to the U.S. on flowering peach in the 1870s. It is now a pest of all fruit trees and many ornamental and wild trees and shrubs throughout the U.S., particularly in hot, dry climates. Oystershell scale is European in origin and has been in the US since around 1850. San Jose scale is differentiated from other scale insects by the scale (shell) that covers the adult females. The scale is hard, gray to black, and cone-shaped. The scale has a tiny white knob in the center with a series of grooves or rings around it. Oystershell scale looks like a miniature oyster. Although oystershell scale is principally a pest of woody parts of the plant (although it occasionally attacks fruit), San Jose scale attacks woody parts and fruit. Scales are related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Severe infestations by San Jose scale can kill twigs and even the whole tree. Large quantities of honeydew are produced, which makes leaves and fruit shiny and sticky. Sooty mold fungus may colonize the honeydew, giving the plants a dirty, sooty appearance, further restricting photosynthetic activity. Fruit damaged by San Jose scale is characterized by red halos that form around the feeding site.

Biology and life history San Jose scale overwinters in an immature life stage and is black in color. In spring, the tiny winged males emerge and mate with wingless females. Females give birth to live young about a month later (no eggs). The young scales, called “crawlers,” are very small, flattened, and yellow, and move around on bark and foliage before settling down to feed. Young scales are dispersed by wind, rain, irrigation, or by the movement of people and machinery. A few days later, they secrete a waxy coating over their body that protects them from pesticides. From this point, female scales do not move. Crawlers are found during June and July and again in August to September, so there are two generations per year. Oystershell scale overwinters as eggs under the female scale. Crawlers emerge in May and June and move to feeding sites on the bark. They secrete a waxy coating and the females remain sedentary. Males emerge from their coating and mate with the females. Once the females lay eggs beneath their bodies, they gradually shrink in size and die after the last eggs are laid. There is one generation per year.

Scouting and thresholds Inspect twigs during the dormant season for scales. Pay particular attention to weak plants. Observe the young bark for purplish-red halos that indicate scale infestation. The crawlers are best observed during June to July with a 10X magnifying glass. Crawlers can be monitored by wrapping a piece of double-sided tape around an infested branch or by applying a tacky insect glue barrier.

Management—biological control

Larvae of green lacewings and other insects are aggressive predators of scale. However, biological control does not necessarily prevent significant scale infestations.

Management—cultural control

Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. Tanglefoot, “stickem,” or a similar adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer, as this favors increased scale populations.

Management—chemical control: HOME USE

Stages 0-1: Egg control with dormant & delayed-dormant sprays

Oils are effective against San Jose scale, but are not very effective against oystershell scale. Apply sprays during dormant or delayed-dormant period (March to April). Do not use after pink appears in buds. Use enough water to cover the tree thoroughly including small limbs and shoots.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- horticultural mineral oil, plus one of the following: lime-sulfur, lime-sulfur materials such as polysulfide—Some formulations are OMRI-listed for organic use.

Spring and summer

Insecticide applications are aimed at the vulnerable crawlers during mid-summer. Apply insecticides about 10 days after full petal fall (all petals are off) or 17 to 21 days after full bloom. Avoid making applications of insecticides to plants in bloom to avoid bee injury. Follow all label directions.

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 0-2: Egg control with dormant & delayed-dormant sprays

- buprofezin (Centaur WDG) at 34.5 oz/A applied as a ground application using a minimum of 20 gallons of water per acre. Do not make more than one application per growing season. REI 12 hr. [Group 16]
- diazinon (Diazinon 50W) at 4 lb/A + horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. Do not apply more than one application as a dormant spray per year. REI 4 days. [Group 1B]
- horticultural mineral oil at 4 to 8 gal/A in up to 400 gal water. REI varies by formulation- See label.
- lime sulfur (calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. REI 2 days. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A plus horticultural mineral oil at 4 to 8 gal/A in up to 400 gal water per application. Do not exceed two applications per season. Do not apply earlier than 14 days after last Esteem treatment. REI 12 hr. [Group 7C]

Stages 3-4: Prepink & tight cluster sprays

- buprofezin (Centaur WDG) at 34.5 oz/A applied as a ground application using a minimum of 20 gallons of water per acre. Do not make more than one application per growing season. REI 12 hr. [Group 16]
- diazinon (Diazinon 50W) at 4 lb/A in up to 100 gal water per application. Do not apply more than one application as an in-season spray per year. REI 4 days. [Group 1B]
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz of product/A per 100 gal water per application. Do not exceed two applications per season. REI 12 hr. [Group 7C]

Pink & petal fall sprays

- buprofezin (Centaur WDG) at 34.5 oz/A as a ground application using a minimum of 20 gallons of water per acre. Do not make more than one application per growing season. REI 12 hr. PHI 14 days. [Group 16]
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications or 10 oz/A per growing season. REI 12 hr. PHI 45 days. [Group 7C]

Spring and summer

Long-term control can be achieved only with delayed-dormant sprays; however, fruit infestation can be prevented with summer applications.

- acetamiprid (Assail 70WP) at 3.4 oz/A in up to 100 gal water per application. Do not make more than four applications per year or exceed 13.5 oz/A per growing season. Will provide suppression. REI 12 hr. PHI 7 days. [Group 4A]
- buprofezin (Centaur WDG) at 34.5 oz/A as a ground application using a minimum of 20 gal water per acre. Do not make more than one application per growing season. REI 12 hr. PHI 14 days. [Group 16]
- diazinon (Diazinon 50W) at 4 lb of product/A in up to 100 gal water per application. Do not apply more than one application as an in-season spray. REI 4 days. PHI 21 days. [Group 1B]
- imidacloprid (Admire Pro) at 2.8 fl oz/A in up to 100 gal water per application. Do not use within 10 days prior to bloom or when bees are actively foraging. Do not exceed 14 fl oz/A per season. REI 12 hr. PHI 7 days. [Group 4A]
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A in up to 100 gal water per application. Do not exceed two applications per growing season. REI 12 hr. PHI 45 days. [Group 7C]
- spirotetramat (Movento) at 6 to 9 fl oz/A. Do not exceed 25 fl oz /A per growing season. Apply after petal fall. REI 24 hr. PHI 7 days [Group 23].
- sulfoxaflor (Transform WG) at 0.75 to 1.5 oz/A in up to 100 gal water per application. Suppression only. See supplemental label. No more than four applications per season. PHI 7 days [Group 4C]

Apple—Shothole borer

Includes
Shothole borer (*Scolytus rugulosus*)
European shothole borer/pear blight beetle (*Anisandrus dispar*)
Lesser shothole borer (*Xyleborinus saxesenii*)

Pest description and crop damage Shothole borers, also known as ambrosia beetles, are small beetles that were introduced to North America and have been found in the PNW since the early 1900s. Apple, pear, cherry, and plum all are attacked. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees are attacked. The adult shothole borer is a brownish black beetle about 0.08 inch long. The larvae are white, legless, and about 0.17 inch long. The other shothole borers are smaller—about 0.12 inch long, dark brown or black, and covered with yellowish hairs. The larva is pinkish-white, legless, cylindrical, and 0.17 inch long when mature. Larvae and adults of both these species bore into the cambial and vascular tissues of trees, weakening them and causing wilting and dieback of individual stems and branches. Trunks and branches can be riddled with galleries.

Biology and life history Shothole borers overwinter as a larva burrowed beneath the bark of infested trees. They pupate beneath the bark. Adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. The adults tunnel into the tree, excavating galleries parallel to the wood grain. They lay eggs along the gallery. The eggs hatch, and the larvae feed by tunneling at right angles to the main burrow, causing a characteristic pattern of damage. After 6 to 8 weeks, the larvae pupate at the ends of the galleries. Starting in August, they emerge as adults. The many small, round exit holes this creates gives a "shothole" effect. There are two generations per year.

The other shothole beetles overwinter as a mature larva, pupa, or adult in galleries in the tree. When spring temperatures exceed 65°F, the females become active, fly to susceptible hosts, and bore into the tree. Eggs are laid in the gallery, and as they develop, the female carefully tends them and cultivates ambrosia fungus for them to eat. The females usually remove excrement or wood dust from the tunnels, and this, along with the uniform width of the galleries, distinguishes them from other wood-boring beetles. Young adults can be found tightly packed in the galleries in midsummer, where they remain until the following spring. There is only one generation per year.

Scouting and thresholds Examine branches in late spring for holes 0.08 inch in diameter, oozing sap and sawdust. In stone fruits, these holes often are sealed with gummy ooze. Beetles particularly are attracted to unhealthy trees. Adult beetles are highly attracted to ethanol. Grain spirits can be used to mass-attract beetles to simple jar or bottle traps or commercial traps and lures can be used. Lindgren funnel traps with ethanol lures can capture many adults. Sticky cards will also capture adults, and these cards can be baited with ethanol lures to enhance captures. Monitoring should begin early in the spring.

Management—cultural control

Severe infestations could indicate poor respiration of roots. A common cause of this is poor drainage or excess irrigation. The best management tool is to keep trees healthy with proper pruning, adequate but not excess water, and fertilizer. Healthy trees repel the beetles by plugging borer holes with sap and resins. Remove and destroy infested wood on the tree or piles of infested green wood nearby, especially cherry wood. Beetles also can attack young trees adjacent to piled wood from an old orchard. Burn or remove old, piled wood before replanting. Once the bark on cut wood dries and sloughs off, it is no longer a host for the beetles. Whitewash trunks of young trees to prevent sunburn and reduce potential hazard of attack by shothole borer and flathead borers. Mass trapping may help reduce local populations.

Management—chemical control: HOME USE

The best control is preventative. Choose good planting sites, and maintain healthy trees through adequate, but not excessive irrigation, fertilization, and pruning practices, as well as proper sanitation (remove weak or diseased wood).

Management—chemical control: COMMERCIAL USE

No effective insecticides are labeled for these pests for apples.

Apple—Spider mite

Brown mite (*Bryobia rubrioculus*)
European red mite (*Panonychus ulmi*)
McDaniel mite (*Tetranychus mcdanieli*)
Two-spotted spider mite (*Tetranychus urticae*)
Yellow spider mite (*Eotetranychus carpini*)

For mite identification, see:

Field Characteristics of Fruit-Tree-Attacking Spider Mites in the PNW

Pest description and crop damage All adult mites are small, usually only about 0.02 inch long and have eight legs. The various apple-infesting species vary in appearance as follows:

Brown mite: The adult female is a dull reddish brown with dark orange markings, and somewhat flattened. The front legs are very long, over twice the length of the other legs, and extend forward from the body.

European red mite: Adults are globular, reddish with white spines. Immatures are similar in appearance, only smaller. Eggs red and globular.

Two-spotted or McDaniel mite: Adults are yellowish-brown, about 0.02 inch long. Two-spotted mites have two dark spots on the body, while McDaniel mites have four. Immatures are similar in appearance, only smaller. Eggs are round and translucent to opaque.

Yellow spider mite: Adult females are pale yellow to white with 2 or 3 dark, rectangular markings on each side of the abdomen. Immatures are similar in appearance to the two-spotted spider mite, but have more of a yellowish color. Eggs are clear and spherical.

Spider mites damage leaves by puncturing cells and sucking out the contents. This produces small yellow-white spots on the upper leaf surface. In heavy infestations, the spots coalesce and the leaf yellows or bronzes.

Biology and life history Two-spotted, McDaniel and yellow spider mites overwinter as fertilized females under bark or in soil debris. European red mite and brown mites overwinter as eggs in crevices of twig bark and young limbs. They move to young foliage when buds break in spring and produce many generations during spring to autumn. Females can lay up to 10 eggs per day and more than 200 during their lifetime. Egg-to-adult development can occur in 7 to 10 days during summer. They thrive under hot, dry conditions. Large colonies of mites produce webbing. Dispersal occurs mainly through wind transport.

Scouting and thresholds Thresholds have not been established, but economic damage is unlikely at levels below 15 to 20 per leaf. Treatment thresholds always must consider the presence of predatory mites, which are major biological control agents (see below).

Management—biological control

Spider mite populations are held down by cool, wet conditions early in the season. Considerable natural control is provided by lady beetles (*Stethorus* spp.) and minute pirate bugs (*Orius* spp.). Predator mites such as *Typhlodromus* spp. or *Neoseiulus fallacis* (syn. *Amblyseius fallacis)* are also effective at managing populations of spider mites and may be purchased. Avoid broad-spectrum insecticide sprays to protect predators.

Management—cultural control

Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. The use of cover crops also reduces dust and mite problems. Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Mites may be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control: HOME USE

Stages 0-1: dormant & delayed-dormant spray

horticultural mineral oil—Some formulations OMRI-listed for organic use.

Spring and summer

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Avoid spraying when blossoms are open. May require several applications. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- sulfur—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Stages 0-1: Egg control with dormant & delayed-dormant sprays

- hexythiazox (Savey 50WP) at 3 to 6 oz/A in up to 100 gal water per application. To avoid resistance development, apply hexythiazox only once per season. Hexythiazox is an ovicide and will not control adult mites: combine with adulticide if adults are present. REI 12 hr. [Group 10A]
- horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. REI varies by formulation; see label. Some formulations are OMRI-listed for organic use.
- sulfur (dry flowable)— Formulations vary; see label for rates. Apply with suitable spray oil during bud dormancy only. REI 24 hr. Some formulations are OMRI-listed for organic use. Potential for phytotoxicity with hot temperatures and with sensitive apple varieties.
- lime sulfur (calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil at 6 to 8 gal/A in up to 400 gal water. REI 2 days. Some formulations are OMRI-listed for organic use.
- micronized wettable sulfur (Microthiol Disperss) 10 to 20 lb/A. Dilute applications 100 to 800 gal water, concentrated applications 20 to 100 gal. Note: certain apple varieties may be sensitive to sulfur. REI 24 hr. OMRI-listed for organic use.

Stages 3-4: Egg Control with Prepink & tight cluster sprays

- clofentezine (Apollo SC) at 4 to 8 oz/A per growing season. To avoid resistance development, apply Apollo only once per season. Apollo is an ovicide and will not control adult mites. REI 12 hr. [Group 10A]
- hexythiazox (Savey 50DF) at 3 to 6 oz/A in up to 100 gal water per application. To avoid resistance development, apply hexythiazox only once per season. Hexythiazox is an ovicide and will not control adult mites. Combine with adulticide if adults are present. REI 12 hr. [Group 10A]

Spring and summer

Choice of miticide varies with species of mite present, selectivity to predatory mites, and other factors, such as resistance present in an area.

- abamectin (Abamex) at 10 to 20 oz/A in up to 100 gal water per application. Apply when mites first appear. Apply only during petal fall and up to six weeks following petal fall. Do not apply more than two applications per growing season. REI 12 hr. PHI 28 days. [Group 6]
- acequinocyl (Kanemite 15SC) at 21 to 31 fl oz/A in up to 100 gal water per application. Do not exceed two applications per season. REI 12 hr. PHI 14 days. [Group 20B]

- bifenazate (Acramite 50WS) at 0.75 to 1 lb of product/A in up to 100 gal water per application. Do not exceed one application per season. Do not use with oil on Golden Delicious due to risk of phytotoxicity. REI 12 hr. PHI 7 days.
- clofentezine (Apollo SC) at 4 to 8 oz/A in up to 100 gal water per application. Do not exceed one application of Apollo per season. Apollo is an ovicide and will not control adult mites. REI 12 hr. PHI 45 days. [Group 10A]
- cyflumetofen (Nealta) at 13.7 fl oz/A in minimum of 100 gal water per application. Do not exceed two applications of Nealta per season. REI 12 hr. PHI 7 days. [Group 25]
- etoxazole (Zeal 72WDG) at 2 to 3 oz/A in up to 100 gal water per application. Only one application per season. REI 12 hr. PHI 14 days. [Group 10B]
- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb of product/A in up to 100 gal water per application. Do not apply more than two times per growing season. REI 2 days. PHI 14 days. [Group 12B]
- fenpyroximate (Fujimite 5SC) at 2 pints/A in a minimum of 100 gal water per acre. Also see Fujimite XLO. Only one application per season. Do not apply by alternate row middle spray method. REI 12 hr. PHI 14 days. [Group 21A]
- hexythiazox (Savey 50WP) at 3 to 6 oz/A in up to 100 gal water per application. To avoid resistance development, apply hexythiazox only once per season. Hexythiazox is an ovicide and will not control adults. Combine with adulticide if adults are present. REI 12 hr. PHI 28 days. [Group 10A]
- pyridaben (Nexter) at 6.6 to 10.67 oz/A in up to 100 gal water per application. Apply as populations begin to build, between petal fall and harvest. Do not exceed one application per season. Lower rates can be used for control of European red mite; higher rates are required for control of twospotted or McDaniel spider mites. Also controls apple rust mite. REI 12 hr. PHI 25 days. [Group 21]
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz product/A in a minimum of 100 gal water per application. Do not apply more than one application or 18 fl oz product/A per growing season. REI 12 hr. PHI 7 days. [Group 23]

Resistance management Spider mites develop resistance rapidly to chemical controls. Alternate chemistries and modes of action.

Apple—Stink bug

Brown marmorated stink bug (*Halyomorpha halys*)
Consperse stink bug (*Euschistus conspersus*)
Green stink bug (*Chinavia hilaris*)

Pest description and crop damage Adult stink bugs are all shield-shaped, with a triangle-shaped section in the middle of their backs. They are generally up to about 0.5 to 0.6 inch long. The name stink bug refers to the strong odor the insects can emit if alarmed.

The consperse and green stink bugs are native pests, and the brown marmorated stink bug is an invasive pest that is an increasing problem in apples in some regions of the PNW.

See:

Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

The adult consperse stink bug is pale brown, yellow underneath with red antennae. The adult green stink bug is bright green. Nymphs are similar in shape to the adults and come in a variety of colors. Brown marmorated stink bug (BMSB) is characterized by white bands on the coal-colored antennae and legs; a distinct brown "marbled" color on the back that consists of flecks of different brown colors; red eyes; and an underside that may be cream, pink, red, yellow or green. Stink bugs cause damage to plants by sucking sap from buds, leaves, stems or fruits. Cat-facing damage on fruit indicates early season damage. Late season damage may be difficult to detect and worsens in storage. Areas of corky cells will be apparent beneath the skin of the fruit, and these will brown with oxidation. Stink bug damage can superficially resemble the physiological disorder known as bitter pit, but stink bug damage tends to originate within 0.4 inch of the fruit surface, while bitter pit damage can occur throughout the fruit. Note that chemical controls tend to be very disruptive to orchard natural enemies.

Biology and life history Native stink bug adults overwinter in groundcover. They feed early in the season on weeds and may move later into other host plants. Stink bug damage is worst in dry summers when alternative hosts are dried up. BMSB adults overwinter in human structures including homes, shops and outbuildings. Rock outcrops, leaf litter, and dead standing timber may also be used as overwintering sites for BMSB. BMSB move out from overwintering sites into orchards in the spring where they may begin to reproduce. They may also immigrate in from forest or riparian borders, or other crops throughout the growing season.

Management—biological control

Egg parasitoids attack native stink bug eggs. Parasitic flies (Tachinidae) attack native stink bug nymphs and adults and lay eggs on them. The egg hatches and the fly larva then penetrates the host stink bug and consumes it from the inside. Native stink bug egg parasitoids and parasitic flies have little effect on BMSB, but an adventive egg parasitoid called samurai wasp (*Trissolcus japonicus)* is now establishing across the PNW. Predators of different life stages include lacewings, ladybird beetles, ground beetles, web-making spiders, praying mantids and others. Orchard practices that conserve natural enemies will benefit stink bug management.

Management—cultural control

For native stink bugs: manage weedy vegetation within and around the orchard (especially blackberry, mustard and radish). Do not mow cover crops or weeds when stink bugs are present since mowing may cause bugs to disperse to the fruit trees. Home orchardists can use mesh or paper bags to protect fruit from damage. Home orchardists may also be able to hand-remove stink bugs and egg masses from trees.

Management—chemical control: HOME USE

Spring and summer

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

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Late spring and summer

- beta-cyfluthrin (Baythroid) 2 to 2.4 fl oz in up to 100 gal water per application. Do not exceed 2.8 fl oz/A per season. REI 12 hr. PHI 14 days. [Group 3]
- clothianidin (Belay) at 4 to 6 fl oz/A. Do not apply more than 12 fl oz of Belay per acre per season. REI 12 hr. PHI 7 days. Do not feed or allow livestock to graze on cover crops from treated orchards. [Group 4A]
- cyfluthrin (Tombstone) at 2.4 to 2.8 fl oz/A in no less than 100 gal water per application. Do not exceed 2.8 fl oz/A per growing season. REI 12 hr. PHI 7 days. [Group 3A]
- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz of product/A in up to 100 gal water per application. Very toxic to predatory mites. Foliar use may cause spider mite outbreaks. This pesticide is not compatible with integrated control programs for spider mites. REI 12 hr. PHI 21 days. [Group 3]
- fenpropathrin (Danitol 2.4 EC) at 16 to 21.3 fl oz/A in up to 100 gal water per application. Do not exceed 42.7 fl oz/A per season. Highly toxic to fish, bees, and wildlife. REI 24 hr. PHI 14 days. [Group 3A]
- gamma-cyhalothrin (Declare) at 1.02 to 2.05 fl oz in enough water to achieve good coverage. REI 24 hr. PHI days [Group 3A].
- kaolin (Surround WP) at 25 to 50 lb/A applied as a spray to leaves, stems, and fruit. Continue applications every 7 to 14 days to assure adequate coverage on newly growing plant surfaces. Kaolin acts as a repellant to target pests. REI 4 hr. PHI 0 days. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz in enough water to achieve thorough coverage. REI 24 hr. PHI 21 days. [Group 3]
- methomyl (Lannate) at 1.5 to 3 pints per acre in up to 100 gal water. REI 72 hr. PHI 14 days. Ground application only. Danger: high acute human toxicity. [Group 1A]
- novaluron (Rimon) at 20 to 30 fl oz/A in up to 100 gal water per application. Targets nymphal stages tank mix with adulticide to target adults. Do not apply more than 150 fl oz per growing season. REI 12 hr. PHI 14 days. [Group 15]
- sulfoxaflor (Transform WG) at 0.75 to 1.5 oz/A in up to 100 gal water per application. See supplemental label. No more than 4 applications per season. PHI 7 days [Group 4C]
- zeta-cypermethrin (Mustang Maxx) at 4 fl oz/A in a minimum of 100 gal water for dilute spray. REI 12 hr. PHI 14 days. [Group 3A]

Apple—Tent caterpillar

Forest tent caterpillar (*Malacosoma disstria*)
Western tent caterpillar (*Malacosoma californicum*)

Pest description and crop damage The western tent caterpillar and the forest caterpillar are the main tent caterpillar pests in the PNW. These insects attack a wide variety of plants—including alder, ash, birch, cottonwood, and willow—as well as fruit trees and roses. The adult moths are stout-bodied, light to darker brown, and are active in early to midsummer. They are attracted to lights at night.

Larvae of the forest tent caterpillar are about 2 inches long, blue, with black spattered markings as well as white, footprint-shape marks. Larvae of the western tent caterpillar are hairy, dull yellow-brown, with rows of blue and orange spots on the body. Eggs of these moths are laid on twigs or buildings in masses. These are brown to gray, about 0.06 inch long, and look like Styrofoam.

The larvae of both species feed in large groups on foliage of host plants and can cause significant damage by defoliation. Larvae of western tent caterpillars build large silken tents over leaves on which they feed. Larvae of forest tent caterpillars build mats of webbing rather than tents. Larvae can totally defoliate small trees, which may not kill them but reduces growth and makes the trees more susceptible to diseases or poor weather. Healthy trees usually will grow new leaves by midsummer.

Biology and life history The moths overwinter as egg masses on twigs or buildings. The eggs hatch in spring as buds break in April or May. The young larvae feed in groups for 5 to 6 weeks, growing larger and molting (shedding skins) four times. As they mature, they split into smaller groups and move to new feeding sites in the tree. The larvae pupate starting in mid-June, and the adults emerge 7 to 10 days later. The adults, mate, and lay overwintering eggs. There is one generation per year.

Scouting and thresholds Look for egg masses on twigs or other overwintering sites, and remove them. Masses of young larvae are identified easily in early spring.

Management—biological control

Infestations of tent caterpillars occur cyclically as populations of the caterpillars and their predators rise and fall. Tent caterpillars have many natural

enemies. Some birds eat the caterpillars, and small mammals consume the pupae. The larvae of a tachinid fly parasitizes the caterpillars.

Management—cultural control

Home orchardists: Remove egg masses from twigs or other sites. Cut out infested twigs and dip in a bucket of soapy water.

Management—chemical control: HOME USE

Spring and summer

Spray in spring after overwintering eggs hatch, at about the time leaves are 0.75 to 1 inch long. Control is much more effective if sprays are applied when larvae are small.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Insecticides used for other lepidopterous apple pests are effective and these pests are not normally a problem in orchards with active spray programs.

Apple—Thrips

Includes
Pear thrips (*Taeniothrips inconsequens*)
Western flower thrips (*Frankliniella occidentalis*)

Pest description and crop damage Adult thrips are small (about 0.04 inch long at maturity), slender insects with fringed wings. They are generally white when young but brown or black when mature. Larvae are very tiny and difficult to distinguish without magnification. In apples, thrips feed on developing fruits which causes a white “pansy spot” to develop.

Biology and life history The western flower thrips has several generations and is a widespread problem on tree fruits and other crops in the PNW. Damage to apples occurs during bloom, when female thrips lay eggs into developing fruit. A pale area, known as “pansy spot,” develops around the scar where eggs were deposited, and is especially noticeable on light-skin apple cultivars. If only one spray is applied, pink and petal fall timings give equivalent control.

The pear thrips has only one generation and destroys the fruit buds and flowers of fruit trees during bloom. This pest has become a localized problem in the mid-Columbia fruit-growing area, especially in orchards that border habitat with native hosts such as maple and other deciduous trees. Use a beating tray during pink stage to monitor and detect immigrating pear thrips along border rows of orchard. Pear thrips is best controlled at early pink stage.

Management—cultural control

Manage weedy vegetation within and around the orchard (especially blackberry, mustard and radish). Do not mow cover crops or weeds, since mowing may cause thrips to disperse to the fruit trees.

Management—chemical control: HOME USE

Stages 5-6: Pink spray

- acetamiprid
- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against thrips. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Stages 5-6: Pink spray

- *Chromobacterium subtsugae (*Grandevo) at 2 to 3 lb/A. Under heavy pest populations, apply a knockdown insecticide prior to use or in a tank mix, use the higher label rates, shorten the spray interval, and/or increase the spray volume to improve coverage. REI 4 hr. OMRI-listed for organic use.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A in up to 100 gal water per application. Do not exceed four applications per growing season. REI 4 hr. [Group 5]
- spinosad (Entrust 80WP) at 2 to 3 oz /A in up to 100 gal water per application. Do not exceed 9 oz /A per season. REI 4 hr. [Group 5] OMRI-listed for organic use.
- tolfenpyrad (Bexar) at 21 to 27 oz/A in up to 100 gal water per application. See supplemental label. Aerial applications not allowed. No more than two applications. REI 12 hr. PHI 14 days. [Group 21A]

Apple—Woolly apple aphid

Eriosoma lanigerum

Pest description and crop damage Adult woolly apple aphids are reddish to purple and are completely covered with a thick, woolly white wax. The insects feed on roots, trunks, limbs and shoots, producing galls at the site of the infestation. Heavy infestations on roots or above-ground portions of the tree can stunt growth and even kill young trees.

Biology and life history These aphids overwinter as adults on roots and aerial parts of apple trees. In severe winters, the aboveground colonies may be killed. In spring and early summer, nymphs move up and down the tree to find a new spot to settle and produce new colonies. Preferred feeding sites are leaf axils on new shoots.

Scouting and thresholds Inspect trees during the growing season for the characteristic white, waxy colonies. Aerial colonies are mainly found in rough areas of bark and in wounds caused by pruning.

Management—biological control

Lacewings, lady beetles and syrphid fly larvae are predators, as well as the parasitic wasp *Aphelinus mali.* The predators will consume all but the waxy secretion left by the aphids.

Management—cultural control

This aphid is considered a minor pest in the PNW. If colonies are found on trees, they can be physically removed. Many Geneva and Malling-Merton rootstocks are resistant.

Management—chemical control: HOME USE

Spring and summer

- carbaryl—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed.
- malathion—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer

- diazinon (Diazinon 50W) at 4 lb of product/A in up to 100 gal water per application. Do not apply more than one application as an in-season spray. REI 4 days. PHI 21 days. [Group 1B]
- flonicamid (Beleaf 50 SG) at 2.0 to 2.8 oz of product/A in up to 100 gal water per application. Do not apply more than three applications per season. REI 12 hr. PHI 21 days. [Group 29]
- flupyradifurone (Sivanto) at 6.0 to 7.0 fl oz/A in up to 100 gal water per application. Suppression only. REI 4 hr. PHI 14 day.
- imidacloprid (Admire Pro and generics) at 7 to 10.5 fl oz/A chemigation or root drench depending on label. Do not apply prior to bloom or when bees are actively foraging. Do not apply more than 10.5 oz product/A per growing season. REI 12 hr. PHI 21 days.
- thiamethoxam (Actara WDG) at 4.5 to 5.5 oz/A in up to 100 gal water per application. Do not exceed 16.5 oz/A per season. REI 12 hr. PHI 35 days. [Group 4A]
- sulfoxaflor (Transform WG) at 0.75 to 1.5 oz/A in up to 100 gal water per application. See supplemental label. No more than 4 applications per season. PHI 7 days [Group 4C]

Apricot Pests

Heather Stoven, Chris Adams, and Michael R. Bush

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INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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.

The following suggests the amount of each formulation per acre when applied to mature trees. The size of trees, amount of foliage, type of equipment used, and other factors are important in determining the amount of spray to use per acre.

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

Mite identification: See Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest.

Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control. Active ingredients marketed under other product names may provide equivalent control, but read product label first to check legal status before making any application.

Apricot—Aphid and mealybug

Includes
Hop aphid (*Phorodon humuli*)
Mealy plum aphid (*Hyalopterus pruni*)
Thistle aphid (*Brachycaudus cardui)*
Grape mealybug (*Pseudococcus maritimus*)

Pest description and crop damage Several aphid species attack apricots, including the hop aphid, mealy plum aphid, and thistle aphid. Aphids tend to be teardrop-shaped, translucent green insects that measure less than 0.1 inch long. Adults of the thistle and mealy plum aphids are pale bluish green to brownish green; mealy plum aphid has a white, powdery coating. Hop aphid is pale yellowish green, winged forms are green to black. Both adult and immature aphids feed on plants by injecting their needle-like mouthparts into green tissues and sucking out plant juices. Early in the season, aphid feeding can stunt and deform shoot growth. Later in spring, feeding can lead to leaf curling, or, at high aphid abundances, shoot dieback and damaged fruit. Aphids excrete large amounts of sticky honeydew that can cover surfaces of leaves and fruit. Fungi and molds colonize the honeydew and can leave dark spots on the surface of the fruit, compromising appearance and quality.

Newly hatched mealybug nymphs, or crawlers, are about 0.06 inch long, pink-to-salmon colored, coated with a white powder wax, and very mobile. The more mature, sedentary nymphs are pink-to-purple with waxy filaments giving them a whitish cast. Adult females resemble nymphs and are about 0.2 inch long and mobile. Later in the season, mealybugs may produce copious amounts of honeydew. This honeydew may be colonized by black sooty mold that can discolor leaf and fruit surfaces.

Biology and life history Aphid species associated with apricots tend to overwinter in fruit trees as dark rice-shaped eggs hidden in cracks and crevices along tree bark, twigs, and buds. There are multiple aphid generations each year. Later generations reproduce asexually and bear live young (foregoing the egg stage). In the late spring and early summer, most aphid populations develop wings and leave fruit trees for a multitude of summer hosts like vegetable crops and weed species.

Grape mealybug overwinters as crawlers in egg sacs beneath bark scales and in cracks. Crawlers start emerging from egg sacs at the beginning of bud swell and begin feeding on the bases of buds. As buds open, the crawlers go directly to new shoots and leaves. Once settled, the crawlers start feeding, become progressively sedentary and harder to kill. First generation nymphs mature during late June and July in the Northwest. Adult males appear first, mate with last instar nymphs or adult females and die. Receptive females release a pheromone to attract males. Mated females migrate to sheltered areas, lay eggs and die in the egg sac. A partial second generation matures in late August and September.

Pest monitoring Observe shoots for aphid and mealybug presence prior to budbreak. Effective management is best undertaken while the aphid and mealybug populations are at their lowest density early in the spring.

Management—biological and cultural control

Several parasitic wasps, predatory lacewings, lady beetles, syrphid fly larvae, and other insects play an important role in controlling aphids and grape mealybugs.

Management—cultural control

Wash aphids from plants with a strong stream of water or by hand-wiping. Aphid populations tend to be higher in plants that are fertilized too liberally with nitrogen. Avoid excessive watering, or late season nitrogen applications that produce flushes of succulent growth. Most aphid species leave apricots in June–July for summer hosts and return to fruit trees in the autumn.

Management—chemical control

Dormant to delayed dormant applications target overwintering eggs and newly emerged aphid populations when their abundance in the fruit trees is lowest; spray coverage of exposed fruit tree surfaces is essential. Sprays applied during the growing season are meant to target rapidly increasing aphid populations and should be applied before leaves curl to avoid protecting aphid populations from spray residue. These applications may reduce mealybug and leafroller abundance as well. Applications to mealybugs during earlier life stages can be more effective due to a reduced quantity of protective wax covering their bodies.

Management—chemical control: HOME USE

Dormant to delayed-dormant season spray

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Aphids only. Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids and mealybugs. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—REI varies; check product label. Some formulations are OMRI-listed for organic use.

Prebloom and in-season sprays

In some cases, these products have caused more damage than good by reducing beneficial insects. For best results, apply insecticides before leaves begin to curl, and before petal fall.

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. Diazinon is toxic to bees. Do not use if bloom is present and/or bees are foraging in the orchard. Note: Diazinon is limited to one application as a foliar spray per season.
- horticultural mineral oil (rates vary; check product label)—REI varies; check product label. Some formulations are OMRI-listed for organic use.
- phosmet (Imidan 70W) at 0.75 to 1 lb/100 gal water (4.25 lb/A). REI 7 days. Extremely toxic to fish; avoid spray drift and surface runoff.

Petal fall spray

- acetamiprid (Assail 30SG) at 5.3 oz/A. REI 12 hr. PHI 7 days.
- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. PHI 21 days. Diazinon is toxic to bees. Do not use during bloom or if bees are foraging in the orchard. Diazinon is limited to one application as a foliar spray per season.
- imidacloprid (Prey 1.6F, Nuprid 1.6) at 2 fl oz/100 gal water (4 to 8 fl oz/A). REI 12 hr. PHI 0 days. Do not apply during pre-bloom, bloom, or when bees are actively foraging.

Apricot—Catfacing insects

Includes
Plant bugs (*Lygus hesperus* and *L. lineolaris*)
Stink bugs including Consperse stink bug (*Euschistus conspersus*)

See also:

Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

Pest description and crop damage Adult plant bugs are flattened, semi-oval insects 0.15 to 0.20 inch long. They can be yellow, green, and dark brown to black with a conspicuous yellow or pale green triangle on the back. Adult stink bugs have a flattened shield shape. Length ranges from 0. 5 to 0.7 inch and color from gray to brown to green. Stink bugs are noisy fliers, with long, piercing-sucking mouth parts.

Bug feeding damage causes dimpling and sunken spots on young fruit that can deform the shape of the fruit by harvest (often referred to as catfacing). Internal fruit damage appears as white corky areas under the surface of the fruit. Feeding may deform or kill buds and shoots. These bugs have an extremely wide host range that includes field and vegetable crops, hay crops, natural vegetation in uncultivated land and weeds in adjacent areas. These pests do not reproduce on tree crops but invade from outside hosts.

Biology and life history Adults overwinter in groundcover. Early in the season, they feed on weeds in groundcover and adjacent fields. Later in the summer as alternative hosts dry up, these bugs may move into the canopy of fruit trees.

Pest monitoring Periodically scout the canopy of fruit trees for the presence of adult plant and stink bugs, particularly in trees with a history of bug damage to the fruit. Critical times to scout are when the adjacent weed hosts are drying up or nearby host crops are being harvested. Brown marmorated stink bug can be monitored with commercial lure-baited pyramid traps.

Management—cultural control

When possible, do not plant apricot trees adjacent to hay fields, weedy lots, or uncultivated land. Proper weed management early in the season can reduce the attractiveness of an orchard to these pests. DO NOT mow orchard floor within two weeks of fruit harvest as any bug infestation in the ground cover will move to the tree canopy.

Management—chemical control

Spray applications, primarily pyrethroid products, target adult bugs. These products work best as spray residues that intercept plant and stink bugs as they move between alternative host sources and fruit trees.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Prebloom/Growing-season sprays

- esfenvalerate (Asana XL) at 2 to 5.8 fl oz/100 gal water of dilute spray (4.8 to 14.5 fl oz/A of concentrate). REI 12 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters. Do not spray more than 0.375 lb/A per season, with no more than 0.3 lb/A between bloom and harvest.
- lambda-cyhalothrin (Warrior II with Zeon Technology) at 1.28 to 2.56 fl oz/A (0.02 to 0.04 lb/A). REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.

Apricot—Earwig

Forficula spp., primarily the European earwig (*Forficula auricularia*)

Pest description and crop damage Earwigs are slender, reddish-brown insects with a pair of forceps-like appendages at the tail end. A mature adult earwig ranges from 0.5 to 0.6 inch in length and has wings tucked under a covering (elytra). Immature earwigs are similar in appearance to the adults except smaller and wingless. Earwigs are nocturnal and hide under tree bark or soil debris during the day. They can prey on soft-bodied insects or scavenge on decaying vegetation. Earwigs can climb trees and chew holes between leaf veins, but this damage is rarely of any consequence. Earwigs can become pests when they chew irregular, shallow holes on ripening or overripe fruit.

Biology and life history Earwigs overwinter just below the soil surface as both eggs and adults. In spring, females lay 20 to 50 smooth white to cream-color eggs in the soil. The young progress through four to five nymphal stages to adults by late summer. In fall, females may lay more eggs and may be found guarding her eggs through the winter. Earwigs are active at night. During the day, they hide in moist, shady places such as compost piles or beneath stones, boards, and debris. They sometimes can be found in homes, particularly in summer, but they do not damage home or household contents. They rarely fly but can move rapidly and have a tendency to climb, so are often found in fruit trees. They are attracted to lights at night.

Pest monitoring Periodically scout fruit trees for signs of chewing insect leaf damage. If damage to young leaves is detected, confirm the presence of earwigs by placing corrugated cardboard, flat boards, roofing tiles or similar material on the ground that will provide daytime shelter for the nocturnal earwigs. Check the materials each morning for presence of the insects. Infestations spread slowly as earwigs rarely fly. For tree ripened fruit, be sure to monitor earwig populations prior to harvest.

Management—cultural control

Earwig abundance can be reduced by removing weeds and plant debris away from base of trees. Banding tree trunks with plastic wrap covered with sticky adhesive can prevent movement of earwigs into the tree canopy.

Management—chemical control

Some of these treatments specifically target and intercept immature and adult earwigs as they climb into the tree canopy at night.

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Apply as a spray around the trunk. Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—When sprayed on leaves, trunks and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- malathion—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Summer spray

- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A. REI 12 hr. PHI 3 days. Apply on trunk and base of trees. Extremely toxic to aquatic invertebrates; avoid runoff and spray drift to surface waters. Limited to 3 in-season applications per year.

Apricot—Eriophyid mite

Primarily the peach silver mite (*Aculus fockeui*)

Pest description and crop damage Translucent to yellow, teardrop-shaped mites (roughly 0.006 inch long) that are difficult to see without the aid of a 10X hand lens. Mites feed on the surface of leaves. Feeding may cause a silvery appearance on the foliage and may lead to premature leaf drop.

Biology and life history These mites overwinter as diapausing females in buds immediately under the bud scales, or in cracks along the bark. As buds expand in the spring, females leave their overwintering sites, begin feeding, and then after a few days, lay eggs. In the spring, eggs may take two weeks to hatch, but by midsummer they may hatch in as little as 3 to 4 days. There are several generations per year. As the foliage deteriorates in late summer, diapausing females are produced.

Pest monitoring Observe the leaves for signs of mite feeding and use a hand lens to check for the mites particularly in fruit trees with a history of eriophyid mite infestations. Growing populations of eriophyid mites can be determined by successive sampling during the dormant, delayed-dormant period or early spring.

Management—biological control

Eriophyid mites serve as a significant food source for predatory mites, so some damage from this eriophyid mite may be tolerated. Predatory mites almost always keep both eriophyid and spider mites under control when broad-spectrum insecticide applications are avoided. Hot, dry weather and the probable hardening off of leaves will reduce eriophyid mite numbers.

Management—chemical control

These applications target active and growing populations of eriophyid mites before they cause leaf bronzing or silvering. Do not apply these products after the damage has been done.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the tree thoroughly including small limbs. Apply during the dormant, delayed-dormant period.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—REI varies; check product label. Some formulations are OMRI-listed for organic use.

Growing-season spray

- pyridaben (Nexter 75WSB) at 4.4 to 10.6 oz/A. REI 12 hr. PHI 300 days. Treat after fruit harvest.
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A (0.28 to 0.31 lb ai/A). REI 12 hr. PHI 2 days. Limited to one application per year; maximum application is 18 fl oz/A or 0.31 ai/A per season.

Apricot—Leafroller

Includes
Fruittree leafroller (*Archips argyrospila*)
Obliquebanded leafroller (*Choristoneura rosaceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage There are several species of leafroller pests in tree fruits. These leafrollers use native plants as well as fruit trees as hosts. They all cause similar damage to the trees, but they differ in their appearance and, more importantly, in their life cycle. The principal leafroller pests of fruit trees can be divided into single-generation moths, such as the fruittree leafroller and the European leafroller; and two-generation moths, such as the obliquebanded leafroller and pandemis leafroller.

The adult moths of these leafrollers range from fawn-color to dark brown. There are distinctive bands or mottling on the wings. Wingspans range from 0.5 to 1 inch. The larvae of these species are all green caterpillars with a light brown to black head, depending on the species. Mature larvae range from 0.75 to 1 inch long.

As the name "leafroller" implies, the larvae roll and tie leaves together for shelter and feeding. They thrash about violently when disturbed and may drop from the leaf suspended by a silken thread. Feeding on growing points on young plants can promote undesirable branching. Larvae also feed on the surface of the fruit, causing deep, russeted scars.

Biology and life history The single generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring as buds are opening until petal fall. The larvae feed for 4 to 6 weeks, then pupate in the rolled leaves and emerge as moths in early summer. The overwintering eggs are laid in July.

Two-generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants. Larvae may feed during warm periods in winter but become active in spring with onset of new growth. They feed for several weeks, and then pupate in rolled leaves. Adults emerge in late April to May. These moths lay eggs for the next generation. The next generation hatches in early summer and does the most damage.

Pest monitoring Observe early spring growth for feeding damage on new leaves or flower petals; later in the spring scout for rolled leaves. Species-specific pheromone traps can monitor moth activity, but moth abundance is not a good indicator of leafroller density and potential damage.

Management—cultural and biological control

Spiders, general predators, and parasitic wasps may reduce these populations. When possible, conserve these predator and parasite populations by avoiding the broad-spectrum insecticides. In home orchards, hand-picking rolled leaves with larvae and pupae reduces leafroller populations.

Management—chemical control

Dormant or delayed-dormant applications target the overwintering life stages of leafrollers. Apply sprays with enough water to cover entire tree thoroughly including small limbs. Apply only during dormant or delayed dormant period. These sprays are most effective on leafrollers with one generation per year that overwinter primarily in the egg stage. Applications during the growing season must be well timed so spray residues contact the newly hatched larvae before they can web leaves together and escape subsequent spray applications.

Management—chemical control: HOME USE

Dormant-season spray

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.

- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

For orchards with a history of leafroller problems, direct cover sprays in the early spring at the overwintering generations for best control. Summer generations of leafrollers are more difficult to control.

Petal fall, spring, and summer sprays

- *Bacillus thuringiensis* var. *kurstaki*—Formulations vary; check label for rates. REI 4 hr. PHI 0 days. Nontoxic to bees. This biologically derived material is slow acting and requires good coverage and multiple applications to be effective. Apply when forecast calls for warm daily temperatures. This material is less effective during cool weather when larvae are not actively eating. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Altacor 35WDG) at 3 to 4.5 oz/A (0.066 to 0.099 lb ai/A). REI 4 hr. PHI 10 days.
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- spinetoram (Delegate 25WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 14 days.
- spinosad (Entrust 80W) at 0.4 to 0.8 oz/100 gal water (1.25 to 2.5 oz/A). REI 4 hr. PHI 14 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Resistance management Leafrollers can develop resistance rapidly to chemical controls. Do not treat consecutive generations with pesticides representing the same chemical group or mode of action. Spinetoram and spinosad are group 5 products.

Apricot—Oriental fruit moth

Aspila (*Grapholita*) *molesta*

Pest description and crop damage Adult is a grayish-brown moth with a wingspan of 0.5 inch. Larvae are creamy white to pinkish caterpillars with black heads and black shields on the thorax and last body segment. Their length ranges from 0.06 to 0.5 inch. Larvae bore and tunnel into shoot terminals, causing leaves and terminal to wilt and die. Larvae may bore into fruit, tunnel, and feed on flesh. Distribution of this pest appears to be spotty here in the Pacific Northwest with isolated populations found primarily in neglected backyard fruit trees. This insect has not been a problem in Oregon orchards for several years.

Biology and life history This insect overwinters as fully grown larvae in a hibernacula enclosed in silk webbing on ground cover or tree crevices. In spring, pupation occurs, and adults appear near bloom. Eggs are laid on foliage and the larvae feed by boring into the growing shoots. There may be 3-4 generations per year. Later generations also attack fruit before seeking overwintering sites.

Pest monitoring In fruit trees with a confirmed history of Oriental fruit moth infestations, scout for larvae and wilted leaves on shoot and twig tips in early spring. Monitoring traps baited with Oriental fruit moth pheromone can be used to detect the absence/presence of this pest in your area and can help better time pesticide applications.

Management—chemical control

Spray applications and pesticide residues must be well-timed to contact the newly hatched larvae before they bore into the shoot or fruit. For trees with a history of Oriental fruit moth problems, direct cover sprays around petal fall toward the first generation of larvae. Further spray applications in summer may be unnecessary if the first generation has been effectively controlled.

Pheromone mating disruption works best in large orchard blocks and is not considered an effective option for backyard fruit trees.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Petal fall application

- Isomate-OFM/PTB TT at 100 to 200 dispensers/A. These dispensers release a synthetic insect pheromone that disrupts insect mating. Dispensers must be placed in the orchard before adult mating and egg-laying flights begin in spring. Scouting and monitoring are necessary to

use the product effectively.

Spring and summer spray

Warning: These products are toxic to bees. Do not use them during bloom or when bees are foraging in the orchard.

- chlorantraniliprole (Altacor 35 WDG) at 4.5 oz/A (0.099 lb ai/A). REI 4 hr. PHI 10 days.
- methoxyfenozide (Intrepid 2F) at 10 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- phosmet (Imidan 70W) at 0.75 to 1 lb/100 gal water (4.25 lb/A). REI 7 days. PHI 14 days. Extremely toxic to fish; avoid spray drift and surface runoff.
- spinetoram (Delegate 25WG) at 6 to 7 oz/A. REI 4 hr. PHI 14 days.
- spinosad (Entrust 80W) at 0.4 to 0.8 oz/100 gal water (1.25 to 2.5 oz/A). REI 4 hr. PHI 14 days. OMRI-listed for organic use. May act slowly.

Apricot—Peachtree borer

Synanthedon exitiosa

Pest description and crop damage Adult male is a steel-blue, clear-winged moth, the female is similar in appearance but has smoky-colored wings and an orange band around her abdomen. Both male and female moths are approximately 1 inch in length, with males slightly smaller than females. Adult flight is usually from late June through September and eggs are laid at or on the base of the fruit tree. Larvae burrow in the crown and roots, girdle young trees, and weaken others. A single larva can girdle a newly planted fruit tree. Full-grown larvae are 1 to 1.5 inch long with a whitish body and a brown head.

Biology and life history The borer overwinters as a larva under the tree bark, usually below the soil surface. As temperatures rise above 50°F in the spring, larvae resume feeding on the tissues under the bark. Reaching maturity during May through June, the larvae pupate. Adult moths emerge beginning in June and continue to emerge through September. Eggs are laid quickly after mating. The young larvae hatch after 8 to 10 days and bore immediately into the base of the tree. Larvae in the bark above the soil surface usually do not survive the winter in cold areas.

Pest monitoring In late fall or early spring, scout for signs of borer infestation and larval feeding near the base of the tree trunk near the soil surface. Larval presence can best be detected by globs of gum/sap mixed with a granular brown frass that appear at the base of infested fruit trees.

Management—cultural control

Protect the base of the fruit tree from larval entry by placing a plastic or metal cone or barrier around it before egg laying begins. The cone should be pushed 1 to 2 inches into the soil and should fit snugly around the trunk at the top to prevent the tiny larvae from getting beneath it. Alternatively, if there are only one or a few apricot trees in a home orchard, it is quicker and cheaper to control this insect by "worming." Use a pocketknife, wire, or some pointed instrument to remove dirt around the tree and dig out the larvae.

Management—chemical control

Spray applications and, more importantly, pesticide residues on the trunk of the tree can prevent newly hatched larvae from boring beneath the tree bark and entering the woody trunk where they are protected from all insecticide sprays.

Management—chemical control: HOME USE

- azadirachtin—Some formulations are OMRI-listed for organic use,
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- esfenvalerate (Asana XL) at 2 to 5.8 fl oz/100 gal water of dilute spray (4.8 to 14.5 fl oz/A of concentrate). REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters. Do not spray more than 0.375 lb/A per season, with no more than 0.3 lb/A between bloom and harvest.
- Isomate (Isomate PTB) at 100 dispensers/A (0.51 fl oz ai/A). Place prior to moth emergence in the spring. These dispensers release a synthetic insect pheromone that disrupts insect mating. Dispensers must be placed in the orchard before adult mating and egg-laying flight begins in late June or when the first moths are captured in pheromone traps. Careful scouting and monitoring are necessary to use this product effectively.

Apricot—Peach twig borer

Anarsia lineatella

Pest description and crop damage Peach twig borer is a European moth first found in California in the 1880s. It is a major pest of apricots, peaches, plums, and prunes. The adult is a gray moth with white and dark scales, about 0.3 to 0.5 inch long. The larva is a caterpillar, about 0.5 inch long, with a dark brown head and distinctive, alternating light and dark bands on the body. The pupa is smooth and brown. Larvae injure fruit and

trees by feeding on the buds and twigs early in the season. Later in the season, the larva bores into the shoots causing a characteristic “flagging” or wilting of the new growth. Later generations of larvae feed on shoots or fruit, disfiguring the fruit. Flagging of twigs indicates an infestation.

Biology and life history The borer overwinters as an immature larva in tunnels constructed within the crotches of twigs and branches. These overwintering sites can be identified by the small chimneys of frass and wood fragments produced by the feeding of the larvae. Larvae become active by the pink bud stage and emerge to feed on buds and young leaves. Later the larvae will bore into shoots. These larvae eventually leave the mined shoots to pupate. Adults then emerge in mid-to-late May. Eggs are laid on fruit, shoots, or undersides of leaves. Eggs are yellowish white to orange. The eggs hatch, and these larva feed on shoots and immature fruit. The next adult flight is in mid-July. Some of the larvae from this flight overwinter, the rest produce a partial third flight.

Pest monitoring Use pheromone traps to time sprays to target the young larvae before they bore into tissues. Scout for flagging of shoots early in season. Detection indicates a need to protect fruit from later generations of peach twig borer.

Management—cultural control

Cut out and destroy mined shoots below the wilted area to eliminate larvae. Overwintering larvae may be found and destroyed under thin bark in branch crotches. Look for a buildup of chewed bark and frass (excrement).

Management—chemical control

Early sprays aimed at the newly-hatched larvae, before they bore into the shoot or fruit, will provide the best control of peach twig borer.

Management—chemical control: HOME USE

Dormant-season spray

- superior-type oil—Some formulations OMRI-listed for organic use.

Growing-season spray

For most effective control, target the young larvae with cover sprays during pre-bloom or petal fall.

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin —Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations may be OMRI-listed as organic.
- spinosad—Some formulations may be OMRI-listed as organic.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

For most effective control, target the young larvae with cover sprays during pre-bloom or petal fall.

Delayed-dormant and prebloom spray

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- horticultural mineral oil (rates vary, check product label) + carbaryl (Carbaryl 4L) at 4 to 5 quarts/A. REI 12 hr. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- chlorantraniliprole (Altacor 35 WDG) at 3 to 4.5 oz/A (0.066 to 0.099 lb ai/A). REI 4 hr. May be applied with a registered horticultural mineral oil.
- phosmet (Imidan 70W) at 0.75 to 1 lb/100 gal water (4.25 lb/A). REI 7 days. Extremely toxic to fish; avoid spray drift and runoff to surface waters.
- spinetoram (Delegate 25WG) at 3.0 to 7 oz/A. REI 4 hr.
- spinosad (Entrust 80W) at 0.4 to 0.8 oz/100 gal water (1.25 to 2.5 oz/A). REI 4 hr. OMRI-listed for organic use. May act slowly.

Bloom spray

- *Bacillus thuringiensis* var. *kurstaki*—Formulations vary; check label for rates. REI 4 hr. Nontoxic to bees. This biologically derived material is slow acting and requires good coverage and multiple applications to be effective. Apply when forecast calls for warm daily temperatures. This acts as a stomach poison and is less effective during cool weather, when larvae are not actively feeding. Some formulations are OMRI-listed for organic use.

Petal fall, spring, and summer sprays

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- *Bacillus thuringiensis* var. *kurstaki*—Formulations vary; check label for rates. REI 4 hr. PHI 0 days. Nontoxic to bees. This biologically de-

rived material is slow acting and requires good coverage and multiple applications to be effective. Apply when forecast calls for warm daily temperatures. This acts as a stomach poison and is less effective during cool weather, when larvae are not actively feeding. Some formulations are OMRI-listed for organic use.

- chlorantraniliprole (Altacor 35 WDG) at 3 to 4.5 oz/A (0.066 to 0.099 lb ai/A). REI 4 hr. PHI 10 days.
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- phosmet (Imidan 70W) at 0.75 to 1 lb/100 gal water (4.25 lb/A). REI 7 days. PHI 14 days. Extremely toxic to fish; avoid runoff and spray drift to surface waters.
- spinetoram (Delegate 25WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 14 days.
- spinosad (Entrust 80W) at 0.4 to 0.8 oz/100 gal water (1.25 to 2.5 oz/A). REI 4 hr. PHI 14 days. OMRI-listed for organic use. May act slowly.

Apricot—Scale

European fruit lecanium scale (*Parthenolecanium corni*)

Pest description and crop damage Adult scales are up to 0.2 inch across, reddish brown and rounded, resembling small helmets or bumps on branches, stems, and the underside of leaves. The crawlers are flat, oval, and pinkish brown. Scales are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Severe infestations can kill twigs. Large quantities of honeydew are produced that may cause russeting on fruit and growth of sooty mold fungus.

Biology and life history Lecanium scale overwinters as an immature scale on twigs and branches. They resume feeding in the spring, and eggs are laid underneath the scales in May to June. The eggs remain under the scales until hatching in early summer. The young scales, called "crawlers," migrate to the undersides of leaves to feed. Young scales also can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After 4 to 6 weeks on the leaves, the young return to the stems and twigs to feed, mate, and overwinter. There is one generation per year.

Pest monitoring Overwintering scales can be monitored by collecting spur samples during the dormant season. The presence of honeydew or sooty mold on fruit at harvest indicates a need for pest management next season.

Management—cultural control

Major infestations can be pruned off. Sticky adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer or water applications, as these favor improved viability of the populations. In home orchards, scales can be rubbed off plants by hand with a glove or toothbrush.

Management—biological control

Parasitic wasps and lady beetles play an important role in suppressing scale insects.

Management—chemical control

The best time to control scale insects is during the delayed-dormant period. These applications target and smother the non-motile overwintering adult and egg stages. If spring and summer scale control is required, apply during the crawler period (June).

Management—chemical control: HOME USE

Dormant-season spray

Use enough spray to cover the entire tree thoroughly including small limbs and shoots. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins——Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant to delayed-dormant spray

- diazinon (Diazinon 50W) at 4 lb/A + horticultural mineral oil (rates vary; check product label). REI 4 days. Diazinon is limited to one dormant season application per season regardless of target pest.
- horticultural mineral oil (rates vary; check product label)—REI varies; check product label. Horticultural oils at this timing are sufficient to control light to moderate populations of scale. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A + horticultural mineral oil (rates vary; check product label). REI 12 hr. Esteem is an insect

growth regulator with good activity toward the scale egg stage.

Prebloom spray

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. PHI 21 days. Diazinon is limited to one in-season application per season regardless of target pest.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 14 days. Esteem is an insect growth regulator.

Apricot—Spider mite

Primarily
European red spider mite (*Panonychus ulmi*)
McDaniel spider mite (*Tetranychus mcdanieli*)
Twospotted spider mite (*Tetranychus urticae*)
Yellow spider mite (*Eotetranychus carpini borealis*)

Pest description and crop damage All adult mites are small, usually only about 0.02 inch long and have eight legs. The various apricot-infesting species vary in appearance as follows:

European red spider mite: Adults are globular, reddish with white spines. Immature mites are similar in appearance, only smaller. Eggs are red and globular.

Twospotted and McDaniel spider mite: Adults are yellowish-brown, about 0.01 to 0.02 inch long. Twospotted mites have two dark spots on the body, while McDaniel mites have four. Immature mites are similar in appearance, only smaller. Eggs are round and translucent to opaque.

Yellow spider mite: Adult females are pale yellow to white with two or three dark, rectangular markings on each side of the abdomen. Immature mites are similar in appearance to the twospotted spider mite but have more of a yellowish color. Eggs are clear and spherical.

These spider mites damage tissues by puncturing individual plant cells, then sucking the contents out of the cell. The damage appears as small yellow-white spots on the upper leaf surface. In heavy infestations, the spots coalesce and the leaf yellows or bronzes.

For mite identification, see:

Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest

Biology and life history McDaniel, twospotted, and yellow spider mites overwinter as fertilized females under bark or in soil debris. European red spider mite overwinters as eggs in crevices of twig bark and young limbs. They move to young foliage when buds break in spring and produce many generations during spring to autumn. Females can lay up to ten eggs per day and more than 200 during their lifetime. Egg-to-adult development can occur in seven to ten days during summer. They thrive under hot, dry conditions. Large colonies of mites produce webbing along leaf midveins. Mite dispersal occurs mainly through wind transport.

Pest monitoring Scout your tree periodically during the summer months for stippled or yellowing leaves, especially in trees with a history of spider mite damage or water-stressed trees. Confirm the presence of mites by using a hand lens to view the undersides of leaves for the mites, their eggs and webbing.

Management—biological control

Spider mite populations are held down by cool, wet conditions early in the season. Considerable natural control is provided by lady beetles (*Stethorus* spp.) and minute pirate bugs (*Orius* spp.). Predator mites such as *Typhlodromus* spp. or *Neoseiulus fallacis* are also effective at managing populations of spider mites and may be commercially available. Avoid broad-spectrum and pyrethroid sprays during the growing season due to their negative effect on natural enemies.

Management—cultural control

Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. The use of cover crops also reduces dust and mite problems. Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Mites may be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control

When applied during the dormant or delayed dormant season, horticultural oils can greatly reduce European red spider mite populations later in the season.

Management—chemical control: HOME USE

Dormant-season spray

- superior-type oil (European red spider mite only)—Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Avoid spraying when blossoms are present. Complete coverage, especially undersides of leaves, is essential. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.

- pyrethrins—Highly toxic to bees. Some formulations may be OMRI-listed as organic.
- spinosad—Some formulations may be OMRI-listed as organic.

Management—chemical control: COMMERCIAL USE

In recent years, several effective miticide products have become available with multiple modes of action that target different life stages of spider mites.

Dormant to delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—REI varies; check product label. Some formulations are OMRI-listed for organic use.

Spring and summer sprays

- bifenazate (Acramite 50 WS) at 0.75 to 1 lb/A. REI 12 hr. PHI 3 days. Only one application per crop season.
- clofentezine (Apollo SC) at 4 to 8 oz/A. REI 12 hr. PHI 21 days. Only one application per season. Must be applied early in the season when mite population is predominantly in egg stage. Do not apply within 100 ft of an aquatic habitat.
- hexythiazox (Savey 50 DF) at 3 to 6 oz/A. REI 12 hr. PHI 28 days. Apply at first sign of egg deposition, before adult mites build up. Does not significantly control adult mites. Only one application per crop season.
- spirodiclofen (Envidor 2 SC) at 16 to 18 fl oz/A. REI 12 hr. PHI 7 days. Only one application per crop season.

Resistance management Spider mites can develop resistance rapidly to chemical controls.

Apricot—Spotted-wing drosophila

Drosophila suzukii

For pest description, crop damage, biology, life history, and cultural management

See:

Spotted-wing Drosophila: An Emerging Berry and Stone Fruit Pest

Pest monitoring Monitor for spotted-wing drosophila (SWD) with clear quart-sized plastic deli cups with lids. Drill or puncture about ten 3/16 inch holes near the rim of the cup for fly entry. Bait traps with pure apple cider vinegar plus a drop of unscented liquid soap. Hang the trap in a shady, cool location within the plant tree canopy. Place as many traps as you can maintain in your susceptible crops just before fruit starts to ripen. Check traps weekly. There are various kinds of flies that will be captured in this non-specific trap so learn to identify SWD and have positive catches confirmed by your local Extension office. Adult SWD males have spots on their wings. Treatment thresholds have not been established, but preventive measures should be taken when the first SWD is captured, and fruit starts to ripen. SWD was captured in mid-May in the Mid-Columbia area, earlier west of the Cascades. Watch the SWD website for regional detections of SWD (http://spottedwing.org). Monitoring guidelines are based on the data currently available and designed for ease of grower adoption and use.

Management—cultural control

Spotted-wing drosophila larvae can develop in either ripening or dropped fruit of many fruits and berries, both wild and cultivated. Harvest fruit in a timely manner and clean up dropped or infested fruit. Eliminate excess vegetation that can provide refuge and reproductive habitat. SWD prefers high humidity and shelter from direct sunlight. Manipulation of the microclimate can provide important population control for this pest. Drip irrigation, weed barrier fabric, and heavy pruning to create an open canopy have all been shown to reduce infestation.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use. This product has been shown to provide some control of SWD.
- kaolin—When sprayed on leaves, trunks, and fruit, kaolin acts as a repellant to some insects. Some formulations are OMRI-listed for organic use.
- insecticidal soap—Avoid spraying when blossoms are present. Complete coverage, especially undersides of leaves, is essential. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use. These products have been shown to provide good control of SWD but have no residual activity.
- spinosad—Some formulations are OMRI-listed for organic use. This product generally provides good to excellent control and 5 to 7 days of residual activity.
- zeta-cypermethrin—Highly toxic to bees. This product has been shown to provide excellent control of SWD.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. PHI 21 days. A maximum of one in-season foliar application regardless of target pest.
- esfenvalerate (Asana XL) at 2 to 5.8 fl oz/100 gal water of dilute spray (4.8 to 14.5 fl oz/A of concentrated spray). REI 12 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters. Do not spray more than 0.375 lb/A per season, with no more than 0.3 lb/A between bloom and harvest.
- lambda-cyhalothrin (Warrior II 1CS) at 1.3 to 2.5 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.

- malathion (Malathion 57EC) at 2 pints/A. REI 12 hr. PHI 6 days. Maximum number of applications per year is two.
- spinetoram (Delegate 25WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 14 days. Apply at least 1 week apart, with a maximum of 4 applications per season.
- spinosad (Entrust 80W) at 0.4 to 0.8 oz/100 gal water (1.25 to 2.5 oz/A). REI 4 hr. PHI 14 days. OMRI-listed for organic use. May act slowly.

Cherry (Sweet and Sour) Pests

Ashley Thompson, Heather Stoven, and Chris Adams

Latest revision—March 2024

INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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: To prolong the effectiveness of insecticides, an effective insect resistance management program must be part of an IPM program that involves sampling and monitoring, treatment thresholds, and biological and cultural control. Do not use pesticides with the same mode of action on back-to-back generations of a pest.

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

For mite identification, see:
Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest.

Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control. Active ingredients marketed under other product names may provide equivalent control: read product label first to check legal status before making any application.

Cherry—Apple-and-thorn skeletonizer

Choreutis pariana

Pest description and crop damage The adult moth is reddish brown, with a wingspread less than 0.5 inch, and irregular light and dark bands on the wings. Larvae are 0.5 inch long, yellowish to greenish, with black spots and a yellow-brown head. Pupae are yellow to brown with a white silken cocoon. The larvae skeletonize and roll leaves. They feed on apple, crabapple, cherry, and hawthorn.

Biology and life history Adult moths overwinter in crevices in the tree. They lay eggs in small bunches on the undersides of leaves. The larvae emerge and feed on the underside of the leaves, then move to the top surface and feed there, often tying the sides together creating a "rolled" effect. After 3 to 4 weeks, larvae pupate in the rolled leaf. Adults emerge about two weeks later to start a new generation. There are at least two generations per year.

Pest monitoring Watch for signs of skeletonizing, which from a distance looks like the leaf tips have been burned.

Management—biological control

There are many natural enemies of this pest. Avoid broad-spectrum pesticides that would disrupt this system.

Management—cultural control

Hand remove larvae and pupae from rolled leaves. Prune out heavily infested twigs.

Management—chemical control: HOME USE

There are no products registered for control of this pest.

Cherry—Black cherry aphid

Myzus cerasi

Pest description and crop damage The adult aphid is black, globular in shape and about 0.125 inch long. Black cherry aphid is the only black aphid on cherry. These aphids curl foliage, reduce terminal growth, and deposit honeydew on cherries, which can be difficult to remove prior to commercial packing. Damage to young trees can be significant.

Biology and life history These aphids overwinter as eggs in crevices and twigs. The eggs hatch near budbreak, and the nymphs feed on unopened buds and the undersides of leaves. Nymphs inject a toxin into leaves, causing them to curl and protect the aphids as they feed. After two to three

generations, winged forms emerge that migrate to summer hosts, which include weeds, ornamental plants, vegetables, and plants of the mustard family. After several more generations, the winged forms migrate back to the fruit trees in the autumn to mate and lay the overwintering eggs.

Pest monitoring Begin observing shoots before budbreak, as management is best undertaken early while the aphids are small and prior to leaf curl.

Management—biological control

Aphids have many natural enemies, which include lady beetles, syrphid fly larvae, and green lacewings. Avoid broad-spectrum insecticide applications that would disrupt these biological controls.

Management—cultural control

Home orchardists: Wash aphids from plants with a strong stream of water or by hand-wiping. Aphids are difficult to control once leaves begin to curl as insects are protected within the curled leaf from direct contact by water and chemicals. Aphid populations tend to be higher in plants fertilized too liberally with nitrogen. Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth.

Management—chemical control: HOME USE

Warning: These pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Warning: These materials are hazardous to bees. Do not use during bloom or if bees are foraging in the orchard.

Dormant-season and delayed-dormant sprays

- diazinon (Diazinon AG500) at 4 pints/A + horticultural mineral oil (rates vary; see product label) or (Diazinon 50W) at 1 lb/100 gal water. Do not exceed 4 lb/A per year (2 lb ai/A per year). Do not exceed 6 gal of oil when applying Diazinon 50WP. REI 4 days. Do not exceed one dormant application of diazinon per season.
- dimethoate (Dimethoate 400 EC) at 1 quart/A. REI 10 days (REI is 14 days in areas where average annual rainfall is less than 25 inches). Do not exceed one pre-harvest application per season. Can cause leaf burning and fruit marking. Do not use on cherries to be exported to Japan.

Spring and summer sprays

- acetamiprid (Assail 70WP) at 2.3 oz/A. REI 12 hr. PHI 7 days.
- diazinon (Diazinon 50W) at 1 lb/100 gal water. Do not exceed 4 lb/A per year (2 lb ai/A per year). REI 4 days. PHI 21 days. Do not exceed one in-season foliar application per year.
- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Asana may aggravate spider mite problems. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- imidacloprid (Prey 1.6F) at 4 to 8 fl oz/A. REI 12 hr. PHI 7 days. Do not use until pollination is complete and bees are no longer present in canopy or ground cover.
- malathion (Malathion 57EC) at 1.5 pints/A. REI 12 hr. PHI 3 days. Malathion may be used in the evening after bee activity. Do not apply within 300 ft of aquatic habitat.
- spirotetramat (Movento) at 6 to 9 fl oz. REI 24 hr. PHI 7 days. Do not apply until after petal fall. Limited to 15.3 fl oz/A per season.
- thiamethoxam (Actara) at 3 to 4 oz/A. REI 12 hr. PHI 14 days. Do not exceed a total of 11.0 oz/A (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam-containing products per acre per growing season.. Actara is extremely toxic to bees exposed to direct treatment or residues.

Cherry—Cherry slug (pear slug, cherry sawfly, pear sawfly)

Caliroa cerasi

Pest description and crop damage The adult is a glossy black wasp, about 0.2 inch long. The larva initially resembles a small slug, due to the olive-green slime that covers the body and the fact that the head is wider than the rest of the body. Mature larvae are 0.37-inch long and orange-yellow. Larvae feed on the upper surface of leaves, skeletonizing them. Heavy feeding causes leaf drop with reduction in vigor and yield, particularly on young trees.

Biology and life history Cherry slug overwinters as a pupa in a cocoon 2 to 3 inches deep in the soil. Adults emerge over an extended period in late April to May. The adult female inserts eggs into leaf tissue, and eggs hatch in 10 to 15 days. Larvae immediately begin to feed on the upper surface of the leaf. After 3 to 4 weeks, they drop to the soil to pupate. Second generation adults emerge in July and larvae from this generation feed in August and September. Most larvae from this generation drop to the ground to overwinter.

Pest monitoring Watch trees for the slug-like larvae in August and September when large populations can build up.

Management—biological control

Specific biocontrol agents are not known, but this is rarely a pest in backyard gardens, so significant biocontrol likely occurs most years.

Management—cultural control

Home orchardists: Pick off individual larvae from infested leaves, or wash them off with a strong stream of water.

Management—chemical control: HOME USE

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- pyrethrin—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 quarts/A). REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters. Apply at 7-day intervals, no more than 3 times per year.
- imidacloprid (Prey 1.6F) at 6.0 to 8.0 fl oz/A. REI 12 hr. PHI 7 days.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 29 fl oz/A per year.

Cherry—Cutworm (climbing)

Many species, including variegated cutworm (*Peridroma saucia*)

Pest description and crop damage Larvae can be brown, gray, or greenish and range from 0.25 to 1.25 inches long. They are most damaging to trees that have high weeds around their bases. Feeding is nocturnal and this feeding may damage leaves and buds. Generally controlled with dormant or delayed-dormant sprays.

Biology and life history Weeds are the preferred source of food for these larvae, and eggs typically are laid on weeds around the trees. Depending on species, they may overwinter as pupae or larvae in the soil. The larvae spend the day in the soil, and then climb up the tree during the night to feed.

Management—cultural control

Control weeds, grasses, and debris in the orchard that provide cover. Encourage natural enemies of cutworms such as spiders. Handpick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime. Tanglefoot or a similar sticky material applied as a band to the trunk will stop movement of larvae up the trunk. Wrap the trunk tightly with plastic wrap to ensure the insects cannot crawl beneath the wrap. Apply the Tanglefoot to the plastic wrap, not the tree, as it can soften bark. **Note:** Young trees can be harmed by banding Tanglefoot directly on thin bark.

Management—chemical control: HOME USE

Climbing cutworms can be difficult to control.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Insecticides applied as a full dilute spray to the tree trunks and bases will control most cutworm species. If other cutworms are involved, spray the whole tree and the ground around the tree. Treat in spring when buds swell or when cutworms become active. Control weeds under trees to keep cutworms from climbing up into the trees.

Cherry—Earwig

Primarily European earwig (*Forficula auricularia*)

Pest description and crop damage Earwigs are elongate, flattened, reddish-brown insects about 0.75 inch long. They are identified easily by the forcep-like pincers on the end of the abdomen. Adults have chewing mouthparts and are winged. Young earwigs (nymphs) are similar in appearance but smaller and lack wings. Earwigs are harmless to humans or animals, though they may give a slight pinch with their forceps. They can emit a foul-smelling liquid if alarmed. Earwigs feed primarily on decaying organic matter and are quite beneficial in that they also consume other small insects. However, they will chew small holes in the leaves and fruit of stone fruit.

Biology and life history Earwigs overwinter as both eggs and adults just below the soil surface. In spring, females lay 20 to 50 smooth white to cream-colored eggs in the soil. The young progress through partial metamorphosis to adults by late summer. In fall, females may lay more eggs and may be found guarding her eggs through the winter. Earwigs are active at night. During the day, they hide in moist, shady places such as compost piles, mulch, misc. debris, or behind plastic trunk guards. They sometimes can be found in homes, particularly in summer, but as they are detritivores, they are not considered a household pest. They rarely fly, but can move rapidly and have a tendency to climb, so are often found in fruit trees. They are attracted to lights at night.

Pest monitoring Home orchardists: If damage to young leaves is seen, the presence of earwigs in the garden can be confirmed by placing a sheet of corrugated cardboard, hollow bamboo cane, sections of old garden hose, or similar material on the ground that will provide shelter in the garden. Check the materials each morning for presence of the insects. Infestations spread slowly, as earwigs rarely fly.

Management—cultural control

Home orchardists: Cultivation of the soil in early spring in areas where earwigs are present will disturb nests and expose eggs to predators. Do not allow debris and decaying organic matter to accumulate in the garden. Earwigs can be trapped by using Tanglefoot, "Stickem," or a similar material applied to the trunk of the tree to prevent their crawling up. Before emergence of the nymphs, wrap the trunk tightly with plastic wrap to ensure the insects cannot crawl beneath the wrap. Apply Tanglefoot adhesive to the plastic wrap, not the tree, as the adhesive can soften bark. Remove these bands before winter. Earwigs also can be trapped and removed following the monitoring techniques described above. Empty traps each morning into a pail of water topped with detergent. Earwigs are attracted strongly to fish oil and to some extent vegetable oil. Insects can be trapped by filling shallow containers with the oil and burying it in soil up to its rim.

Management—biological control

Tachinid flies are predators of earwigs.

Management—chemical control: HOME USE

Apply May to July—

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Apply around bases of trees and on trunks as well as under vegetation and on trash. Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- malathion—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring-summer sprays

- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 quarts/A). REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters. Reapply at 7-day intervals, up to 3 times per crop.

Cherry—Eyespotted bud moth

Spilonota ocellana

Pest description and crop damage Adults are grayish moths about 0.4 inch long with a wide white band on each forewing. Larvae are chocolate-brown with black heads, and up to one inch long. The larvae feed on terminal growth and on the surface of the fruit and can also feed on blossoms early in the season.

Biology and life history Larvae spend the winter in a cocoon on the bark in the crotches of small-diameter limbs. They become active around budbreak and feed on leaves and buds, webbing together leaves and feeding within these nests. After feeding, they pupate within the nest and adult moths emerge in early-to-mid summer. Eggs are laid on the lower surface of leaves. The larvae emerge and feed on the lower leaf surface until early August, at which time they construct their overwintering cocoons (hibernacula).

Pest monitoring Look for larvae in nests of webbed-together leaves in the spring.

Management—chemical control: HOME USE

Warning: These pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during

bloom or if bees are foraging in the orchard.

- carbaryl—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant-season and delayed-dormant sprays

- diazinon (Diazinon AG500) at 4 pints/A + horticultural mineral oil (rates vary; see product label). REI 4 days. Do not exceed one dormant application of diazinon per season.

Spring and summer sprays

Warning: These materials are hazardous to bees. Do not use during bloom or if bees are foraging in the orchard.

- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/A (8 to 16 fl oz/A). REI 4 hr. PHI 7 days. Apply when egg hatch begins or at the first sign of larval infestation. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai of spinosad (29 fl oz/A) per year.

Cherry—Fruittree leafroller

Archips argyrospila

Pest description and crop damage Mature larvae are 0.75 inch long and greenish with a black head. Overwintering eggs start hatching about the time trees begin to bloom. Newly hatched larvae may work into blossoms and damage developing cherries. Larvae damage buds and developing fruit and roll leaves.

Biology and life history The single-generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring as buds are opening until petal fall. The larvae feed for 4 to 6 weeks, then pupate in the rolled leaves, and emerge as moths in early summer. The overwintering eggs are laid in July.

Management—biological control

Spiders and parasitic wasps, as well as predators like the brown lacewing, greatly reduce leafroller populations throughout the year.

Management—cultural control

Hand-pick rolled leaves containing larvae or pupae. Removal of overwintering sites, such as rolled leaves on the ground can reduce next year's population.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- malathion—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant-season spray

- diazinon (Diazinon AG500) at 4 pints/A + horticultural mineral oil (rates vary; see product label). REI 4 days. Do not exceed one dormant application of diazinon per season.
- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A + horticultural mineral oil (rates vary; see product label). REI 12 hr. Pyriproxyfen is a growth regulator with activity toward egg and immature stages only. Under heavy scale pressure, use the higher rate.

Growing-season sprays

Warning: These materials are hazardous to bees. Do not use during bloom or if bees are foraging in the orchard.

- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 quarts/A). REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- chlorantraniliprole (Altacor 35WDG) at 3 to 4.5 oz/A. REI 4 hr. PHI 10 days. Do not apply more than 9 oz/A per season.

- diazinon (Diazinon 50W) at 1 lb/100 gal water. Do not exceed 4 lb/A per year (2 lb ai/A per year). Do not exceed one foliar application per season. REI 4 days. PHI 21 days. Do not apply within 300 ft of aquatic habitat.
- lambda-cyhalothrin (Warrior II) 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- malathion (Malathion 57E) at 1.5 pints/A. REI 12 hr. PHI 3 days.
- methoxyfenozide (Intrepid 2F) at at 0.12 to 0.25 lb ai/A (8 to 16 fl oz/A). REI 4 hr. PHI 7 days. Additional applications at 10- to 18-day intervals at maximum rates may be required for heavy infestations, sustained moth flight, situations in which it is difficult to achieve thorough coverage, and for quicker knockdown of larvae. Do not apply more than 58 fl oz /A per season. See label for biofix information. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Resistance management Fruit tree leafrollers can develop resistance rapidly to chemical controls. Resistance management techniques include using sampling and pest action thresholds to make spray decisions, using higher thresholds on young, non-bearing trees, and rotating pesticides with different modes of action. Spinetoram and spinosad are in the same insecticide class and same mode of action.

Cherry—Leafhopper

Mountain leafhopper (*Colladonus montanus*)
Colladonus reductus
Colladonus geminatus
Euscelidius variegatus
Cherry leafhopper (*Fiebriella florii*)
Scaphytopius acutus
Paraphlepsius irroratus

Pest description and crop damage Leafhoppers are slender, delicate insects about 0.125 inch or less in length. They are distinguishable due to the habit of the adult hopping or flying to escape danger, and by the ability of nymphs and adults to run forwards, backwards, or sideways easily. Several species of leafhoppers are found in cherry orchards, which vary in coloration from green to brown. Leafhoppers suck juices from the leaves of cherries, ornamental plants and weeds. Certain species of leafhoppers are considered serious pests because they can transmit the phytoplasma that causes Western cherry X-disease from infected cherry trees, or various weed species, to healthy cherry trees. Infected trees may produce small misshapen bitter fruit. There is no cure for X-disease and infected trees should be removed to prevent spread.

Biology and life history Varies with the species. Leafhoppers may overwinter as adults, nymphs, or eggs. There may be multiple generations per year. The leafhopper population within the orchard appears to peak after harvest, coincidently this is also when the X disease phytoplasma concentration is greatest within infected trees.

Pest monitoring Place yellow sticky card traps in the cherry canopy during the growing season. Leafhoppers may be present from February through November in some areas. The action threshold remains unknown.

Management—cultural control

Control weeds and alternative hosts such as, clovers, mallow, dandelion, curly dock, bitter cherry, and chokecherry, in and around your orchard.

Management—chemical control: HOME USE

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to target pests. Some formulations are OMRI-listed for organic use.

Management- chemical control: COMMERCIAL USE

Post-harvest insecticides

- acetamiprid (Assail 70WP) at 1.1 to 2.3 oz/A. REI 12 hr. PHI 7 days.
- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 qt/A). REI 12 hr. PHI 3 days.
- esfenvalerate (Asana XL) at 4.8 to 14.5 oz/A. REI 12 hr. PHI 14 days.
- imidacloprid (Prey 1.6F,) at 4 to 8 fl oz/A REI 12 hr. PHI 7 days.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days.
- thiamethoxam (Actara) at 2 to 2.75 oz/A. REI 12 hr. PHI 14 days. Do not exceed 11 oz /A per season. Do not exceed a total of 11.0 oz/Acre (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam-containing products per acre per growing season.

Cherry—Leafroller

Obliquebanded leafroller (*Choristoneura rosaceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage These are similar to fruittree leafroller, but they overwinter as larvae and produce two generations each year.

Pandemis leafroller larvae are green with a green or brown head and are about one inch long when fully grown. Adults are buff-colored moths with dark tan bands on the wings. They can be monitored with pheromone traps. Obliquebanded leafroller (OBLR) larvae are similar to pandemis larvae, except the head is dark brown to black. Larvae feed on leaves and enter cherry fruit, contaminating fruit. OBLR is the dominant leafroller pest in The Dalles and Milton-Freewater, OR.

Biology and life history Second generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants including many native species. Larvae may feed during warm periods in winter but become active in spring with onset of new growth. They feed for several weeks, then pupate in rolled leaves. Adult moths emerge in late April to May. These lay eggs for the second generation. The second generation hatches in early summer during cherry harvest. Larvae can feed in cherries creating small holes or enter through rain induced cracks.

Pest monitoring Observe early spring growth for rolled leaves and feeding damage on new growth.

Management—biological control

Very low temperatures in winter significantly reduce overwintering populations of larvae. Spiders and parasitic wasps as well as predators like the brown lacewing greatly reduce leafroller populations throughout the year.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

Apply April to May

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad —Some formulations are OMRI-listed for organic use. Toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* var. *kurstaki* (Dipel, Javelin, and others)—Check label for rates. REI 4 hr. PHI 0 days. Nontoxic to bees. This biologically derived material acts slowly: effectiveness requires good coverage. Apply when forecast calls for warm daily temperatures. This material is less effective during cool weather when larvae are not actively eating. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Altacor 35WDG) at 3 to 4.5 oz/A. REI 4 hr. PHI 10 days. Do not apply more than 9 oz/A per season.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/A (8 to 16 fl oz/A). REI 4 hr. PHI 7 days. Additional applications at 10- to 18-day intervals at maximum rates may be required for heavy infestations, sustained moth flight, situations in which it is difficult to achieve thorough coverage, and for quicker knockdown of larvae. See label for biofix information. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Maximum of four applications of spinetoram per season. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Resistance management Pandemis leafrollers and obliquebanded leafrollers can develop resistance rapidly to chemical controls.

Cherry—Leaf crumpler and Mineola moth

Leaf crumpler (*Acrobasis indigenella*)
Mineola moth (*Acrobasis tricolorella*)

Pest description and crop damage The leaf crumpler is a pest of a wide range of rosaceous plants, including native species like crabapple, ornamentals such as pyracantha and most tree fruits. The adult moth is light brown with a white patch on each wing and several black lines. Mature larvae are pinkish and about 0.5 inch long. The larvae construct tubes that are attached to twigs of host plants, feeding on developing leaves. They also feed on buds. Second generation larvae burrow into cherries and prunes.

Biology and life history Partially grown brown larvae overwinter in hibernacula (cocoons) on trees. Larvae resume feeding in the spring and leave their nest at night to bring back leaf fragments. Pupation occurs in late spring, and the adults lay eggs on leaves in early June. The majority of feeding for this generation occurs in June and July. The second-generation adults appear in August and lay eggs for the overwintering generation of larvae. In cool areas only a single generation may be produced.

Pest monitoring Look for larvae in nests of webbed-together leaves in the spring.

Management—chemical control: HOME USE

There are no products specifically registered for control of these pests.

Management—chemical control: COMMERCIAL USE

Insecticides applied for fruittree leafroller also control leaf crumpler and mineola moth.

Cherry—Lesser appleworm

Grapholita prunivora

Pest description and crop damage This is a tortricid pest similar in habit to Oriental fruit moth. The larvae feed inside the fruit; often entering through the calyx end. It is an internal fruit feeder. Lesser appleworm is not currently a problem in commercial orchards. It is a moth native to the northeastern US that was first discovered in the Pacific Northwest in the 1940s in the Milton-Freewater area, where it has been most problematic. Insecticides applied for fruittree leafroller control should help control lesser appleworm.

Biology and life history The lesser appleworm prefers host plants in the rose family, including crabapples, hawthorn, wild rose and others. This caterpillar overwinters as mature larvae within a cocoon at the base of host plants under debris. The adults begin to emerge in April, and females lay eggs on leaves or the fruit surface. The larvae feed on the fruit for about three weeks, and then pupate at the base of the tree or under bark scales. Second-generation adults appear in late spring. These also lay eggs on the fruit. Late in the season, mature larvae spin cocoons to overwinter.

Adults and larvae are similar to the codling moth, but all stages are smaller.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season sprays

- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad or 29 fl oz/A per year.

Cherry—Pacific flatheaded borer

Chrysobothris mali

Pest description and crop damage The Pacific flatheaded borer is a pest of many different trees and shrubs, including most fruit trees. Adults are reddish bronze beetles with copper spots on wing covers, and about 0.25 to 0.5-inch long. Larvae are whitish to pale yellow and about 0.5 inch long when fully developed. The area behind the head has a broad, flat enlargement giving the larvae their "flat-headed" appearance. Larvae feed beneath the bark and may girdle the trunks and branches of trees. Young, recently planted trees are most susceptible. Trees that are stressed because of drought or other causes are especially vulnerable.

Biology and life history The insects overwinter in host plants as mature larvae. In spring, they pupate and then bore holes in the tree. They emerge usually from May to June. Females lay eggs from June through July in crevices in the bark, usually on the sunny side of tree trunks below the lowest branches. Stressed trees are the preferred egg-laying site. The larvae hatch, burrow into the wood, and feed on the cambial and vascular tissues until fully grown. Burrows are characteristically broad and irregular.

Pest monitoring Watch for depressions in the bark or cracks through which frass (excrement) may be seen.

Management—biological control

Birds peck the larvae from under the bark with their beaks. Some wasp parasites attack the borer. Carpenter ants eat both larvae and pupae from the wood.

Management—cultural control

Beetles are attracted to weakened, sunburned, or injured parts of trunks and lay eggs in cracks on bark exposed to the sun. Protect young, newly planted trees from sunburn by whitewashing with an interior white latex paint. Paper trunk protectors or boards also may be used to shield the trunks from sun. Limit summer pruning of mature trees to September and early October.

Management—chemical control: HOME USE

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

- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season sprays

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.

Cherry—Peachtree borer

Synanthedon exitiosa

Pest description and crop damage Peachtree borer is a clearwing moth native to North America and common in the Northwest. Adults are a metallic blue-black. The male moth may have bands of light yellow scales on the abdomen, and resembles a wasp. The female has an orange band around the abdomen. Full-grown larvae are one inch long and whitish with a brown head. Larvae burrow into the bark of the crown and feed on the cambium. Feeding is restricted to an area a few inches above and below the soil line. Young trees can be girdled completely and killed. Older trees are rarely girdled, but the feeding reduces vigor and makes them vulnerable to other pests and diseases. Infested trees bleed frass-infested gum during the growing season.

Biology and life history The borer overwinters as a larva on or under the tree bark, usually below ground. As temperatures rise above 50°F in the spring, the larva resumes feeding on the tissues under the bark. At maturity in May and June, the larva pupates. Adult moths emerge beginning in June and continue through September. Eggs are laid quickly after mating, and the young larvae hatch after 8 to 10 days and bore immediately into the base of the tree. Larvae in the bark above the soil line usually do not survive the winter in cold areas.

Pest monitoring This insect can do substantial damage if not controlled—one larva can kill a small tree. Therefore, the finding of a single larva justifies action in a small home orchard.

Management—biological control

Several wasp species are parasitic on the larvae or pupae of the borer.

Management—cultural control

Protect the base of the tree from larval entry by placing a cone around it before egg laying begins. Light metal or flexible plastic works. The cone should be pushed 1 to 2 inches into the soil and should fit snugly around the trunk at the top to prevent the tiny larvae from getting beneath it. Budding tape or other flexible material will help seal the top.

Alternatively, if there are only one or a few peach trees in a home orchard, it is quicker and cheaper to control this insect by worming. Use a pocket knife or some pointed instrument to remove dirt around the tree and dig out the larvae.

Management—chemical control: HOME USE

- gamma-cyhalothrin—Highly toxic to bees.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season sprays

Direct sprays to the trunks and bases of trees. A full dilute drenching spray gives best control.

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- permethrin (Pounce 25WP) at 6.4 to 12.8 oz/A. REI 12 hr. PHI 3 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.

Cherry—Prunus rust mite

Aculus fockeui

Pest description and crop damage The adult mite is a typical eriophyid mite with a cylindrical body, yellow in color early on but changing to brownish yellow or tan with age. The adults are minute and can barely be seen with the naked eye when placed against a black background. Immature mites are similar in structure to the adults but smaller and white. The mites feed on the surface of the leaf with piercing–sucking mouthparts, sucking fluids from the cells. Mature foliage may be curled upward or dwarfed. The lower surfaces of the leaves become brown or bronze. Feeding on younger leaves causes development of small yellow spots on the leaves, followed by shotholing. The impact of this feeding on vigor and yield is uncertain. Prunus rust mites are seldom a problem except on young, unsprayed trees.

Biology and life history The mite overwinters as an adult female under bud scales. As the buds expand, they leave the buds, scatter over the expanding foliage, and feed for several days before laying eggs. A complete generation requires 6 to 22 days, and generations are produced continuously in summer. As foliage hardens or degrades, overwintering females are produced for the following year.

Pest monitoring Observe the leaves for signs of feeding, and use a hand lens to check for the mites.

Management—biological control

Phytoseiid predator mites almost always keep mites under control if broad-spectrum insecticide applications are avoided. Rust mites are a significant food source for these predator mites, so damage from this mite can be tolerated.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly, including small limbs. Apply only during dormant period.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- plant-derived essential oils—Some have shown efficacy against mites. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

- fenbutatin-oxide (Vendex 50WP) at 1.5 to 3 lb/A. REI 2 days. PHI 14 days. Apply when mites first appear. Do not exceed two applications per season.
- horticultural mineral oil—Rates vary; read product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- pyridaben (Nexter 75WSB) at 4.4 to 10.6 oz/A. REI 12 hr. PHI 300 days. Highly toxic to bees. Ground applications only. Do not exceed two applications per season.
- spirodiclofen (Envidor 2SC) at 16 to 18 oz/A. REI 12 hr. PHI 7 days. Limited to one application per season.

Cherry—Redhumped caterpillar

Schizura concinna

Pest description and crop damage The redhumped caterpillar is one of the most widely distributed and commonly encountered large caterpillars in North America. Although the adult moth is an inconspicuous gray moth, the mature larvae are one-inch long and are reddish or yellow and have several spines on each segment. The entire body is lined with white, dark reddish brown, and black lines. The head is red, and the fourth segment behind the head is humped. Larvae usually appear in midsummer and consume the whole leaf, leaving only the midrib. They can completely defoliate individual branches and even entire young trees.

Biology and life history The insect overwinters as a mature larva in a cocoon in the ground. It pupates in early summer, and adult moths appear in June and July. Eggs are laid on lower surfaces of leaves. The caterpillars emerge and feed in groups through September, at which time they move to the ground to construct their overwintering cocoon.

Pest monitoring Examine trees for feeding damage in early summer.

Management—chemical control: HOME USE

- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* var. *kurstaki* (Dipel, Javelin, and others)—Check label for rates. REI 4 hr. PHI 0 days. Nontoxic to bees. This biologically derived material acts slowly. Some formulations are OMRI-listed for organic use.
- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/A (8 to 16 fl oz/A). REI 4 hr. PHI 7 days. Apply when egg hatch begins or at the first sign of larval infestation. Reapply as necessary in 10 to 14 days. Do not apply within 25 ft of aquatic habitat, 150 ft if applied by air.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Maximum four applications per season. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Cherry—Scale

European fruit lecanium (*Parthenolecanium corni*)
San Jose scale (*Quadraspidiotus perniciosus*)

Pest description and crop damage Adult lecanium scales are up to 0.2 inch across, reddish brown, and rounded. They resemble small helmets or bumps on branches, stems, and the underside of leaves. The crawlers are flat, oval, and pinkish brown. San Jose scale was introduced to the U.S. on flowering peach in the 1870s. It is now a pest of all fruit trees and many ornamental and wild trees and shrubs throughout the U.S., particularly in hot, dry climates. San Jose scale can be differentiated from other scale insects by the scale (shell) that covers the adult females. The scale is hard, gray to black, cone-shaped and has a tiny white knob in the center with a series of grooves or rings around it.

Scale are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Infested trees show small, grayish to brownish disk-shape areas or spots and raised surfaces on the bark. Severe infestations can kill twigs. Large quantities of honeydew are produced which causes russeting on fruit and growth of sooty mold fungus. San Jose scale is the more serious pest of this group. It can kill trees and the secondary effect of sooty mold can result in discolored fruit. Lecanium scale can also be a serious pest.

Biology and life history Lecanium scale overwinters in an immature state on twigs and branches. This scale resumes feeding in the spring, and eggs are laid underneath the female (from May to June) where they remain until they hatch in early summer. The young scales, called "crawlers," migrate to the undersides of leaves to feed. Crawlers can also be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After 4 to 6 weeks on the leaves, the crawlers return to the stems and twigs to feed, mate, and overwinter. There is one generation per year.

San Jose scale overwinters in an immature state and is black in color. In spring, the tiny winged males emerge and mate with wingless females. Females give birth to live young about a month later (no eggs are seen). The young scales, called "crawlers," are very small, flattened, and yellow, and move around on bark and foliage before settling down to feed. Young scales also can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. A few days later, they secrete a waxy coating over their body that protects them from pesticides. From this point, female scales do not move. Crawlers are present during June and July and again in August to September, consisting of two generations per year.

Pest monitoring In cherry orchards, leaves of infested trees do not drop in the fall, making detection straightforward. Inspect twigs during the dormant season for scales. Pay particular attention to weak plants. Observe the young bark for purplish-red halos which indicate infestation. The crawlers are best observed during June to July with a 10X magnifying glass. Crawlers can be monitored by wrapping a piece of black sticky tape around an infested branch with the sticky side out.

Management—biological control

Larvae of green lacewings and other insects are aggressive predators of scale. However, biological control does not necessarily prevent significant scale infestations.

Management—cultural control

Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. Tanglefoot, "stickem," or a similar adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer, as this favors increases in the population.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

Control crawlers in mid-June or early July.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant-season spray

- buprofezin (Centaur WDG) at 34.5 oz/A. REI 12 hr.
- methidathion (Supracide 2E) at 8 pints/A. May mix with a horticultural mineral oil (rates vary; see product label). REI 3 days.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. May mix with a horticultural mineral oil (rates vary; refer to product label). REI 12 hr. Pyriproxyfen is a growth regulator with activity towards egg and immature stages only. Under heavy scale pressure, use the higher rate. Do not exceed more than 3 application per season.

Growing-season spray

Apply May to July. Control crawlers in mid-June or early July.

- buprofezin (Centaur WDG) at 34.5 oz/A. REI 12 hr. PHI 14 days. Do not make more than two in-season applications per year.
- diazinon (Diazinon 50W) at 1 lb/100 gal water. Do not exceed 4 lb/A per year (2 lb ai/A per year). REI 4 days. PHI 21 days. Do not exceed one in season foliar application per year. Do not apply within 300 ft of aquatic habitat.
- imidacloprid (Prey 1.6F) at 4 to 8 fl oz/A. REI 12 hr. PHI 7 days. Do not use until pollination is complete and bees are no longer present.

- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 14 days. Do not exceed more than 3 application per season.
- spirotetramat (Movento) at 6 to 9 fl oz. REI 24 hr. PHI 7 days. Do not apply until after petal fall. Limited to 15.3 fl oz/A per season.

Cherry—Shothole borer

Ambrosia beetle (subfamily Scolytinae)
Shothole borer (*Scolytus rugulosus*)

Pest description and crop damage Shothole borers are pests of forest trees, ornamental shade trees, and shrubs as well as fruit trees. Apple, pear, cherry, and plum are all attacked. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees also may be attacked. The adult shothole borer is a brownish-black beetle about 0.12 inch long. The larvae are white, legless, and about 0.17 inch long. A similar wood-boring beetle, the ambrosia beetle, is about 0.12 inch long, dark brown or black, and covered with yellowish hairs. The larva is pinkish-white, legless, cylindrical, and 0.2 inch long when mature. Larvae and adults of both these species bore into the cambial and vascular tissues of trees, weakening them and causing wilting and dieback of individual stems and branches. Trunks and branches become riddled with beetle galleries.

Biology and life history Shothole borer overwinters as a larva in burrows beneath the bark of infested trees. They pupate under the bark and adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. Borers then tunnel into the tree, excavating galleries parallel to the wood grain laying eggs along the gallery. The eggs hatch and the larvae feed by tunneling at right angles to the main burrow, causing a characteristic pattern of damage. The burrows are filled with frass (excrement) and increase in diameter as the larvae mature. After 6 to 8 weeks, the larvae pupate at the ends of the galleries and emerge as adults starting in August. The many small, round exit holes this creates gives a "shothole" effect. There are two generations per year.

Ambrosia beetle overwinters as a mature larva, pupa, or adult in galleries in the tree. When spring temperatures exceed 65°F, the females become active, fly to susceptible hosts, and bore into the tree. Eggs are laid in the gallery, and, as they develop, the female carefully tends them and cultivates ambrosia fungus for them to eat. The females usually remove excrement or wood dust from the tunnels and this, along with the uniform width of the galleries, distinguishes them from other wood-boring beetles. Young adults are found tightly packed in the galleries in midsummer, where they remain until the following spring. There is only one generation per year.

Pest monitoring Examine branches in late spring for holes 0.12 inch in diameter, oozing sap and sawdust. In stone fruits, these holes often are sealed with gummy ooze. Beetles are particularly attracted to unhealthy trees.

Management—cultural control

Destroy or remove all prunings, particularly infested prunings, and keep trees in healthy, vigorous growing condition. Borer attack usually indicates trees are unhealthy. Whitewash trunks of young trees to prevent sunburn and reduce potential hazard of attack by shothole borer and flathead borers.

Management—chemical control: HOME USE

Pesticides must be timed to manage adults and are often not very effective. Cultural techniques are typically the best management practices.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.

Growing-season spray

Direct trunk and limb sprays to infested and neighboring trees when adults are active (late February to early March, June to July, September to October).

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Treat in April. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.

Cherry—Spider mite

Includes
European red mite (*Panonychus ulmi*)
McDaniel spider mite (*Tetranychus mcdanieli*)
Twospotted spider mite (*Tetranychus urticae*)

For mite identification, see:
Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest

Pest description and crop damage Several species of mites can cause damage in tree fruits. The principal mite pests of cherries include the European red mite and the twospotted spider mite. Appearance of these mites varies with the species, although all are very small, 0.02 inch or smaller. Female European red mites are round with red bodies; males are yellowish-red. Twospotted mites are oval and yellowish-brown or green with distinctive black spots on the body. Mites damage fruit indirectly by feeding on leaves, which causes stippling, bronzing, and possibly leaf drop. The reduction in photosynthesis causes loss of tree vigor and yield.

Biology and life history European red mites overwinter as eggs on smaller branches and fruit spurs. They hatch at pink stage and commence feeding. There are six to seven generations per year. Twospotted spider mites overwinter as adult females under bark or in ground cover. They become active in the spring. There may be eight to ten overlapping generations per year.

Pest monitoring Observe the leaves for mites and webbing and check for the number of pest and predator mites. Sufficient control usually is achieved by midsummer by natural enemies.

Management—biological control

Spider mite populations are held down by cool, wet conditions early in the season. Considerable natural control is provided by lady beetles (*Stethorus* spp.) and minute pirate bugs (*Orius tristicolor*). Predator mites such as *Typhlodromus* spp. or *Neoseiulus fallacis* (syn. *Amblyseius fallacis*) are also effective at managing populations of spider mites and may be purchased.

Management—cultural control

Spider mite infestations are favored by dry, dusty conditions, so avoid creating these conditions and/or stressing the plants. The use of cover crops also reduces dust and mite problems. Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Home orchardists: Mites may be washed from the tree with a strong stream of water.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil (European red mite only) —Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—May require several applications. Complete coverage, especially of undersides of leaves, is essential. Apply April to May. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin —Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use
- sulfur—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Dormant-season spray

- diazinon (Diazinon AG500) at 4 pints/A + horticultural mineral oil (rates vary; see product label). REI 4 days. Do not exceed one dormant application of diazinon per season.
- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. May be mixed with a horticultural mineral oil (rates vary; check product label). REI 12 hr. Pyriproxyfen is a growth regulator with activity toward egg and immature stages only. Under heavy scale pressure, use the higher rate. Do not exceed more than 3 application per season.

Growing-season sprays

- bifenazate (Acramite 50WS) at 0.75 to 1 lb/A. REI 12 hr. PHI 3 days. Use only once per season.
- clofentezine (Apollo SC) at 4 to 8 fl oz/A. REI 12 hr. PHI 21 days. Do not exceed one application per season. Must be applied early in the season when the mite population is predominantly in the egg stage.
- etoxazole (Zeal WSP) at 2 to 3 oz/A. REI 12 hr. PHI 7 days. Use only once per season.
- fenbutatin-oxide (Vendex 50WP) at 1.5 to 3 lb/A. REI 2 days. PHI 14 days. Do not exceed two applications or 4.5 lb/A/year.
- hexythiazox (Savey 50DF) at 3 to 6 oz/A. REI 12 hr. PHI 28 days. Does not significantly control adult rust mites. Apply at first sign of egg deposition before adult mites build up. Apply only one hexythiazox product per season.
- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Necrotic foliage may result if applied within 2 weeks of any sulfur application. Some formulations are OMRI-listed for organic use.
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A. REI 12 hr. PHI 7 days. Do not exceed one application/year.

Post-harvest spray

- fenazaquin (Magister) at 32 to 36 fl oz/A. REI 12 hr. PHI 3 days. Do not exceed one application per season.
- propargite (Omite 30WS) at 6 lb/A. REI 2 days. No PHI listed. Do not exceed two applications per season.
- pyridaben (Nexter) at 10.67 oz/A. REI 12 hr. PHI 300 days. Do not exceed two applications per season.

Resistance management Spider mites can develop resistance rapidly to chemical controls. Resistance management techniques include using sampling and pest action thresholds to make spray decisions, using higher thresholds on young, non-bearing trees, and rotating pesticides with different modes of action. Clofentezine, etoxazole, and hexythiazox have the same mode of action as do fenbutatin-oxide and propargite.

Cherry—Spotted-wing drosophila

Drosophila suzukii

For pest description, crop damage, biology, life history, sampling and cultural management

See:
EMERGING PEST: Spotted Wing Drosophila—A Berry and Stone Fruit Pest

Management—chemical control: HOME USE

- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- pyrethrins—These products provide about 80% control of SWD but have no residual activity. Some formulations are OMRI-listed for organic use.
- spinosad—This product generally provides 100% control and 5-7 days residual activity. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Growing-season sprays

Note: When winters are mild, a fall shuck spray can reduce the number of overwintering females.

- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 quarts/A). REI 12 hr. PHI 3 days. At this rate, do not exceed three in-season applications per year. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- esfenvalerate (Asana XL) at 4.8 to 14.5 oz/A. REI 12 hr. PHI 14 days.
- malathion (Malathion 57EC) at 1 pint/A. REI 12 hr. PHI 3 days.
- malathion (Fyfanon ULV Ag) at 16 oz/A. REI 12 hr. PHI 1 day. Not a stand-alone product for SWD control. Do not use sequential sprays for SWD control. Maximum applications per season: sweet cherries- 4; tart cherries- 6.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. No more than four applications per season. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Cherry—Stink bug

Includes
Brown marmorated stink bug (*Halyomorpha halys*)
Consperse stink bug (*Euschistus conspersus*)
Green stink bug (*Chinavia hilaris*)

Pest description and crop damage Adult stink bugs are all shield-shaped, with a triangle-shaped section in the middle of their backs. They are generally up to about 0.5 to 0.6 inch long. The name stink bug refers to the strong odor the insects can emit if alarmed. The consperse stink bug is pale brown, yellow underneath with red antennae. The green stink bug is bright green. Brown marmorated stink bug is brown with alternating white bands on the antennae. Nymphs are similar in shape to the adults and come in a variety of colors. Stink bugs cause damage to plants by sucking sap from buds, flowers or fruits which causes deformities in cherries and make the fruit unsalable. Damaged fruit is pitted, similar to hail damage. Injury usually is confined to fruit clusters or a single limb. Damage may not be visible until fruit begins to ripen.

Biology and life history Adults overwinter in groundcover. They feed early in the season on weeds and may move later into other host plants. Stink bug damage is worst in dry summers, when alternative hosts are dried up.

For further biology and life history as well as sampling and biological control

See:
Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees: do not apply during bloom.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.

- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season spray

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Treat in April. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- kaolin clay (Surround WP) at 25 to 50 lb/A. REI 4 hr. No PHI listed. Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- thiamethoxam (Actara) at 4.5 to 5.5 oz /A. REI 12 hr. PHI 14 days. Actara is extremely toxic to bees exposed to direct treatment or residues. Do not apply Actara between the pre-bloom (swollen bud) and post-bloom (petal fall) growth stages. Do not exceed a total of 11.0 oz/A (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam-containing products per acre per growing season.

Cherry—Syneta beetle

Syneta albida

Pest description and crop damage Adults are up to about 0.4 inch long, creamy or yellowish. The larvae are grub-like, white with a brown head. *Syneta* beetles emerge in early spring. They may emerge and require control between early popcorn and petal fall. Adults chew holes in foliage and fruit stems. Most feeding damage on fruit is pinhead-sized and smaller. Immature cherries are scarred and deformities result. Cherries are the most affected host, but pear, plum, prune, apple, and various nut trees may also be affected. Larvae feed on fibrous roots, but cause only minor damage. This is a pest in the Willamette Valley of Oregon.

Biology and life history This species is restricted to west of the Cascade Mountains. The insect overwinters as larvae in the soil. Pupation occurs in February or early March, and the adults may be found from April through mid-June. Eggs are dropped on the ground, and the larvae hatch and burrow into the soil where they feed on tree roots. When syneta beetle mature, they construct earthen cells and overwinter. There is one generation per year.

Management—chemical control: HOME USE

There are no products specifically registered for control of this pest in the home garden.

Management—chemical control: COMMERCIAL USE

- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Cherry—Tent caterpillar

Includes
Forest caterpillar (*Malacosoma disstria*)
Western tent caterpillar (*Malacosoma californica*)

Pest description and crop damage The western tent caterpillar and the forest caterpillar are the main tent caterpillar pests in the PNW. These insects attack a wide variety of plants, including alder, ash, birch, cottonwood, and willow, as well as fruit trees and roses. The adult moths are stout-bodied, light to darker brown, and are active in early to midsummer. They are attracted to lights at night.

Larvae of the forest tent caterpillar are about two-inches long; blue, with black spattered markings as well as white, footprint-shaped marks. Larvae of the western tent caterpillar are hairy, dull yellow-brown, with rows of blue and orange spots on the body. The larvae of both species feed in large groups on foliage of host plants and can do significant damage by defoliation. Larvae of western tent caterpillars build large silken tents over leaves on which they feed. Larvae of forest tent caterpillars build mats of webbing rather than tents. Larvae can totally defoliate small trees, which may not kill them but reduces growth and makes the trees more susceptible to diseases or poor weather. Healthy trees usually will grow new leaves by midsummer.

Biology and life history The moths overwinter as egg masses on twigs or buildings. The eggs hatch in spring as buds break in April or May. The young larvae feed in groups for 5 to 6 weeks, growing larger and molting (shedding skins) four times. As they mature, they split into smaller groups and move to new feeding sites in the tree. The larvae pupate starting in mid-June, and the adults emerge 7 to 10 days later. The adults fly, mate, and lay overwintering eggs. There is one generation per year.

Pest monitoring Look for egg masses on twigs or other overwintering sites and remove them. Masses of young larvae are identified easily in early spring.

Management—biological control

Infestations of tent caterpillars occur cyclically as populations of the caterpillars and their predators rise and fall. Tent caterpillars have many natural enemies. Some birds eat the caterpillars and small mammals consume the pupae. The larva of a tachinid fly parasitizes the caterpillars.

Management—cultural control

Home orchardists: Remove egg masses from twigs or other sites. Cut out infested twigs and dip in a bucket of soapy water.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

Dormant-season spray

- horticultural mineral oil

Growing-season spray

Spray in spring after overwintering eggs hatch, at about the time leaves are 0.75 to 1 inch long. Control is much more effective if sprays are applied when larvae are small.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—**Highly toxic to bees:** do not apply during bloom.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—May require several applications. Complete coverage is essential. Some formulations are OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Some formulations are OMRI-listed for organic use. Toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Rarely a pest in commercial operations.

Cherry—Thrips

Pear thrips (*Taeniothrips inconsequens*)
Western flower thrips (*Frankliniella occidentalis*)

Pest description and crop damage Adult western flower thrips (WFT) are very small (about 0.04 inch long at maturity), slender insects with fringed wings. They are generally white when young but brown or black when mature. Immature thrips (larvae) are very tiny and difficult to distinguish without magnification. Pear thrips are also very small (0.07 inch at maturity). Adults of these insects are perceived as mere black specks when observed on foliage. Adult pear thrips have two pairs of wings, but are weak fliers. Consequently, dispersal by adults from one infested area to another may be attributed to wind currents. The larvae have red eyes and are pale cream to translucent green which makes them difficult to observe on host foliage. Larvae sometimes congregate in groups on the foliage which makes them more conspicuous.

Female western flower thrips lay eggs in the developing fruit causing a small oviposition scar surrounded by a pale area. In recent years, WFT feeding has been implicated in causing superficial silvery rings where cherries touch each other, especially on late cultivars such as Lapins or Sweetheart. It usually shows up 3 to 4 weeks before harvest, when vegetation surrounding cherry orchards dries up, forcing thrips adults to disperse and move into orchards. Control thrips when adults begin to disperse into orchards of the late-season cultivars. A tentative threshold for controlling thrips at that time is five or more per beating tray.

Feeding by pear thrips causes blasting of buds and ragging of foliage. This pest has recently become a localized problem in the Hood River fruit-growing area, especially in orchards that border habitat with native hosts such as maple and other deciduous trees.

Biology and life history Western flower thrips overwinter as adults in ground duff. In the spring, they seek out flowers where they feed on pollen and nectar and lay eggs into floral parts. The larvae feed on flowers, buds and leaves. When mature, the larvae drop to the ground and pupate. The adults that emerge may lay eggs on developing fruit. Under favorable conditions, a complete life cycle may be completed in two weeks. There are several overlapping generations per year. Seasonal migration occurs at various times of the year due to destruction or drying up of host plants, and adjacent crops may be invaded by these insects. Thrips eat pollen and nectar on a wide range of plants (at least 244 species from 62 families).

Pear thrips are a native of Europe and have been a pest since the early 1900s not only on tree fruit, but on an array of forest trees. This pest spends most of the winter as an adult female in the soil. Adults emerge in early spring and adults disperse to a suitable host and crawl beneath a swollen bud scale to feed on immature tissue, which they can extensively damage. Eggs are laid soon after a suitable host is located. Following egg hatch, the larvae continue to feed while the adult thrips die off. The larvae drop to the soil in late spring and prepare to overwinter.

Scouting and thresholds Use a beating tray during pink stage to monitor and detect immigrating pear thrips or as late season cherries begin to ripen for western flower thrips along border rows of orchard.

Management—cultural control

Avoid disking the orchard floor during bloom or mowing cover crop prior to harvest if thrips are numerous on orchard floor vegetation.

Management—chemical control: HOME USE

Pear thrips are best controlled at early pink stage (early bloom).

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly **toxic to bees:** do not apply during bloom.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches—Highly toxic to bees.
- insecticidal soap—May require several applications. Complete coverage is essential. Some formulations are OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against thrips. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Pear thrips are best controlled at early pink.

- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Western flowers thrips pre-harvest

- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Apply no less than 3 days apart for thrips, with a maximum of four applications per season. Control may be improved by addition of an adjuvant to the spray mixture.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Cherry—Western cherry fruit fly

Rhagoletis indifferens

Pest description and crop damage Adults are somewhat smaller than a house fly and are about 0.2 inch long. They have brownish to black wings with dark bands. White maggots infest cherries. The mature maggot makes a hole in the cherry as it exits. In the Northwest, the western cherry fruit fly infests both home grown and commercial cherries. Western cherry fruit fly is also found in wild bitter cherry (*Prunus emarginata*).

Biology and life history The flies overwinter as pupae in the soil. The adult flies emerge from the soil from mid-May, about 5 weeks before harvest, until the end of July. Peak emergence often coincides with harvest. Adults feed on honeydew on leaves and pollen. After 7 to 10 days, females lay eggs under the skin of the fruit. The eggs hatch, and the larvae burrow toward the pit of the fruit. There they feed for 10 to 21 days before boring out and dropping to the ground to pupate. There is one generation per year. Adults emerge early the following season. A few pupae of western cherry fruit fly may remain in soil as long as 3 years.

Pest monitoring There is no tolerance for cherry fruit fly in cherry fruit, thus the threshold is zero. Degree day models are used to determine first emergence in the major cherry production regions of the Pacific Northwest. Consult with your county Extension agent to determine the development of cherry fruit fly populations in your area. Yellow sticky traps hung in sunny parts of the tree will attract adults. Monitor daily.

Management—cultural control

Home orchardists: Grow early-maturing varieties such as 'Chelan.' Pick fruit within 8 to 9 days of catching the first flies, which will happen before egg hatch. Remove all fruit from the trees to eliminate sites for the fly to reproduce. Cultivation of the soil has not been effective, as the pupae are very hard-shelled.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

Begin spraying late May and continue through harvest. Spray at 10- to 21-day intervals. Degree-days can also be used to better determine fly emergence which is 950 degree-days after March 1.

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches
- kaolin clay (Surround at Home)—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.

- pyrethrins—Some formulations are OMRI-listed for organic use.—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Warning: These materials are hazardous to bees. Do not use during bloom or if bees are foraging in the orchard.

Growing-season sprays

- acetamiprid (Assail 70WP) at 2.3 to 3.4 oz/A. REI 12 hr. PHI 7 days.
- carbaryl (Carbaryl 4L) at 1 to 2 lb ai/A (2 to 3 quarts/A). REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters. Apply at 7-day intervals no more than 3 times per year.
- diazinon (Diazinon 50W) at 1 lb/100 gallons water. Do not exceed 4 lb/A per year (2 lb ai/A per year). REI 4 days. PHI 21 days. Do not exceed one in-season application per year.
- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. May aggravate spider mite problems. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- imidacloprid (Prey 1.6F) at 8 fl oz/A. REI 12 hr. PHI 7 days. Do not use until pollination is complete and bees are no longer present.
- malathion (Malathion 57EC) at 1 pint/A. REI 12 hr. PHI 3 days. May injure certain varieties of sweet cherries. Malathion sprays may be less hazardous to bees.
- malathion (Fyfanon ULV Ag) at 16 oz/A. REI 12 hr. PHI 1 day. Maximum applications per season: sweet cherries- 4; tart cherries- 6. Repeat treatments after heavy rain if label allows.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. PHI 7 days. Maximum four applications per season. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.
- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Do not exceed 0.45 lb ai/A spinosad per year. OMRI-listed for organic use.
- thiamethoxam (Actara) at 4.5 to 5.5 oz. REI 12 hr. PHI 14 days. Repeated applications may cause spider mite buildup. Do not exceed a total of 11.0 oz/Acre (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam-containing products per acre per growing season.

Postharvest spray

- dimethoate (Dimethoate 400EC) at 1 quart/A. REI 10 days (REI 14 days in areas with less than 25 inches/year). One post-harvest application permitted in Oregon, Idaho, and Washington. Do not feed or graze livestock on cover crops in treated orchards. Do not mix with Syllit.

Cherry—Western tentiform leafminer

Phyllonorycter elmaella

Pest description and crop damage Adult moths are small, about 0.12 inch long. The wings are held roof like over the body and are golden bronze with white bands. Eggs are flat, translucent, and laid on the undersides of leaves. The larvae vary in appearance depending on their age, as they progress through five instars. Young larvae are legless and cream-colored. Older instars have legs and are cylindrical in shape, cream-colored and about 0.125 inch long. Mature larvae are yellow and about 0.0625 inch long. The larvae feed within the leaf tissue creating whitish areas on the leaf.

Biology and life history This insect overwinters as pupae in fallen leaves. The adults emerge early in the season and lay eggs on the undersides of leaves around the pink stage of flower bud development. Eggs are flat and translucent. The first three instars of larvae are referred to as sap feeders and feed on spongy soft tissue inside the leaves, creating blotches visible only on the undersurface of the leaves. Later instars are called tissue feeders and develop by early to mid-May. These feed on the upper surface of the leaf beneath the epidermis, spinning silken webs to tie the mine together, giving it the characteristic tent-like appearance, which is visible on the upper leaf surface. Larvae of the first generation then pupate in the leaf. There are three to four overlapping generations per year.

Pest monitoring An average of three eggs per leaf is the proposed action threshold.

Management—biological control

A small parasitic wasp, *Pnigalio flavipes,* provides sufficient control that insecticides may not be required.

Management—chemical control: HOME USE

If required, sprays should be timed after the eggs of a generation have hatched, but before tissue-feeding larvae are observed.

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- lambda-cyhalothrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/A (8 to 16 fl oz/A). REI 4 hr. PHI 7 days. Do not apply within 25 ft of aquatic habitat, 150 ft if applied by air. Reapplication no sooner than 14 days.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Maximum 4 applications per season. Do not apply more than a total of 28 oz of Delegate WG (0.438 lb ai spinetoram) per acre per year.

- spinosad (Entrust SC) at 0.06 to 0.12 lb ai/A (4 to 8 fl oz/A). REI 4 hr. PHI 7 days. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly. Do not exceed 0.45 lb ai/A spinosad (29 fl oz/A) per year.

Cherry—Winter moth

Operophtera brumata

Pest description and crop damage Adults are gray or off-white moths which are present in late fall and winter, hence the name. The larvae are pale green with a light stripe down their sides, up to 0.5 inch long. Larvae damage the buds, blooms, and leaves during the early season but are gone before fruit is large enough to damage. The defoliation can have a negative impact on fruit set and size. Symptoms of leaf feeding are distinct from leafroller larvae as the leaves are tied together with silken threads, but not rolled.

Biology and life history Flightless females deposit 100 to 200 eggs on stems of host plants in late fall and winter. Since the female cannot fly, populations of winter moth often are clumped, as all the eggs usually are deposited in one tree. The eggs hatch in early spring at the green tip stage, and larvae feed from then until petal fall. The larvae often drop on silken threads and are carried by the wind to new growth areas. They drop to the soil to pupate during the summer, and after the first severe frost, the adults emerge. There is one generation per year.

Pest monitoring Beginning in late March, inspect plants for evidence of feeding injury to buds, webbing of leaves, or larvae. Especially in coastal areas, this often will be the first caterpillar visible in the spring.

Management—cultural control

Home orchardists: Pick larvae when you find them and prune out infested growth.

Management—chemical control: HOME USE

There are no products registered for control of this pest in home gardens.

Peach and Nectarine Pests

Michael R. Bush, Heather Stoven, and Chris Adams

Latest revision—March 2024

INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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.

The following management information provides a suggested amount of each formulation per acre when applied to mature trees. The size of trees, amount of foliage, type of equipment used, and other factors are important in determining the amount of spray to use per acre. Carefully read the entire label of each material to be used.

Protect pollinators: Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard. See How to Reduce Bee Poisoning from Pesticides.

Mite identification: See Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest.

Note: Products are listed in alphabetical order and not in order of preference or superiority of pest control. Active ingredients marketed under other product names may provide equivalent control but read product label first to check legal status before making any application.

Peach and nectarine—Aphid

Green peach aphid (*Myzus persicae*)
Mealy plum aphid (*Hyalopterus pruni*)
Rusty plum aphid (*Hysteroneura setariae*)

Pest description and crop damage Several aphid species attack peaches and nectarines, including the green peach aphid, mealy plum aphid, and rusty plum aphid. Green peach aphid adults have yellowish-green, pear-shaped bodies about 0.05 inch long. At certain times each year, adults may develop wings and migrate to other hosts. Nymphs look like the adults but are smaller and wingless. Adults of the mealy plum aphid are pale bluish green to light purple with a white, powdery coating. The rusty plum aphid is rusty brown or deep purple with white bands on the legs and antennae.

The aphids feed initially on the shoot tips, which can cause growth stunting and malformation at the tips of young trees. On older trees, fruit set may be reduced in subsequent years if aphid populations are high. Aphid honeydew production can cause sooty mold problems on fruit. Green peach aphid is a more serious problem on nectarines which lack "fuzz" on the fruit's surface.

Biology and life history These aphids overwinter as eggs in crevices and twigs. The eggs hatch near budbreak, then the nymphs feed on unopened buds and, later, the undersides of the leaves. The leaves curl and protect the aphids as they feed. After two to three generations, winged forms are produced that migrate to summer hosts such as weeds, ornamental plants, vegetables, or plants in the mustard family. After several generations, in the autumn, the winged forms migrate back to the fruit trees to mate and lay the overwintering eggs.

Pest monitoring Observe shoots for eggs and newly hatched aphids prior to budbreak as management is best undertaken while aphid abundance is the lowest and before leaves begin to curl about and protect aphid colonies.

Management—biological control

Aphids are susceptible to several fungal pathogens, including *Beauveria bassiana* packaged as a commercial product. Aphids have many natural enemies, which include lady beetles, syrphid fly larvae, lacewings, and parasitic wasps. Avoid broad-spectrum insecticide applications that would disrupt these natural enemies.

Management—cultural control

Home orchardists: Wash aphids from plants with a strong stream of water or by hand-wiping. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- acetamiprid—Toxic to bees.
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- insecticidal soap—Not recommended for use on yellow-skin nectarine varieties. Some formulations are OMRI-listed for organic use.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant and delayed-dormant sprays

- diazinon (Diazinon AG500) at 1 pint/100 gal water (1.5 to 3 pints/A) + horticultural mineral oil (rates vary; check product label). REI 4 days. Diazinon is limited to one application per season as a dormant spray. Do not apply more than 4 lb product or 6 gal oil per acre. Apply only once during the dormant season.
- esfenvalerate (Asana XL) at 2.0 to 5.8 fl oz/100 gal water (4.8 to 14.5 fl oz/A) + horticultural mineral oil (rates vary; check product label). REI 12 hr.
- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- phosmet (Imidan 70-W) at 1.5 to 3 lb ai/A (2.12 to 4.25 lb/A). Not to exceed 4.25 lb product or 3 lb ai /A per year. REI 7 days. Not labeled for peach or plum aphid but has been found to be effective. Extremely toxic to fish.

Petal fall spray

- acetamiprid (Assail 70WP) at 1.1 to 2.3 oz/A. REI 12 hr. PHI 7 days.
- diazinon (Diazinon 50W) at 1 lb/100 gal water/A (100 gal/A min). Do not exceed 4 lb/A per year (2 lb ai/A per year). REI 4 days. PHI 21 days. Do not exceed one in-season foliar application per year.
- imidacloprid (Prey 1.6F) 4 to 8 fl oz/A. REI 12 hr. PHI 0 day.

Peach and nectarine—Armyworm and cutworm (climbing)

Includes
Bertha armyworm (*Mamestra configurata*)
Spotted cutworm (*Xestia c-nigrum*)
Variegated cutworm (*Peridroma saucia*)

Pest description and crop damage Several species of cutworm, including the spotted cutworm and the variegated cutworm, may be in orchards at various times. Larvae are caterpillars that vary in color from dirty white to greenish or pinkish grey. Mature caterpillars may reach 1.5 to 2 inches long. Depending on species, they may overwinter as pupae or mature larvae in the soil or groundcover. Weeds are the preferred source of food for these larvae, and eggs typically are laid on weeds around the trees. Early in the spring, cutworm species may climb up trees at night and excavate out the developing buds and/or chew ragged holes out of new leaves, particularly those near the base of the tree. The adults are rather nondescript moths ranging in size from 0.5 to 2 inches long and varying in color from gray to brown with unique patterns of spots and bars on their wings.

Pest monitoring In the early spring around bud swell and throughout spring, scout fruit trees for signs of bud or leaf damage, particularly if the orchard or fruit trees have a history of cutworm damage. Confirm cutworm damage by scouting for the caterpillars at night with a flashlight.

Management—cultural control

Control weeds, grasses, and debris in the orchard that provide cover. Weed management prevents initial infestations of cutworms and eliminates natural ladders to lower limbs of the fruit tree. When practical, use a flashlight to find and hand-pick cutworm larvae in the lower canopy or groundcover at night. Caterpillars can be trapped by tying plastic wrap tightly around the base of branches and trunk, then applying sticky adhesive or a similar sticky material to the plastic wrap. Remove these wraps in the autumn.

Management—chemical control

Chemical applications target the overwintering caterpillars that seek to feed on green tree tissues before their normal weed hosts emerge. Later in the

season, these applications target the young actively feeding caterpillars as the older and mature caterpillars tend to be more tolerant of pesticides.

Management—chemical control: HOME USE

- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Peach only. Some formulations are OMRI-listed for organic use.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- methoxyfenozide (Intrepid 2F) at 10 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. OMRI-listed for organic use.

Peach and nectarine—Earwig

Primarily European earwig (*Forficula auricularia*)

Pest description and crop damage Adult earwigs are elongate, flattened, reddish-brown insects about 0.6 inch long. They are easily identified by their forceps-like pincers on the end of the abdomen. Adults have wings that are kept tucked under a short pair of elytra. Immature earwigs are similar in appearance to adults except smaller, wingless, and may be lighter in color. They have chewing mouthparts and feed on soft plant tissue causing damage to flowers and soft fruit.

Biology and life history Earwigs overwinter just below the soil surface as both eggs and adults. In spring, females lay 20 to 50 smooth white- to cream-colored eggs in the soil. Females can often be found guarding eggs and then caring for first instar nymphs. Immatures grow through four to five nymphal stages to become adults by late summer. In fall, females may lay more eggs. Earwigs are active at night. During the day, they hide in moist, shady places such as compost piles or beneath stones, boards, and debris.

Pest monitoring Periodically scout fruit trees for signs of leaf damage. If damage to young leaves is detected, confirm the presence of earwigs by placing corrugated cardboard, flat boards, roofing tiles or similar material on the ground that will provide daytime shelter for the nocturnal earwigs. Check under or within these materials each morning for presence of the insects. Infestations spread slowly as earwigs rarely fly. For tree-ripened fruit, be sure to monitor earwig populations prior to harvest.

Management—cultural control

Earwigs can be monitored and trapped in small boxes filled with newspaper or straw placed at the base of the tree or in strips of corrugated cardboard strapped around the tree trunk. Earwig abundance can be reduced by removing weeds and plant debris away from the base of trees. Banding tree trunks with plastic wrap covered with sticky adhesive can prevent earwigs from moving into the tree canopy.

Management—chemical control

These treatments target and intercept immature and adult earwigs as they climb into the tree canopy at night.

Management—chemical control: HOME USE

- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Not recommended for use on yellow-skin nectarine varieties. Some formulations are OMRI-listed for organic use.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A. REI 12 hr. PHI 3 days. Apply on trunk and soil around trees. Do not exceed three in-season applications per year. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.

Peach and nectarine—Eriophyid mites

Includes
Peach silver mite (*Aculus cornutus*)

Pest description and crop damage Adult mites are extremely small (0.006 inches) and require at least a 10X magnifying lens to scout for them. They are light-color, cylindrical and wedge-shaped. Immature mites are similar in appearance, but smaller and often lighter in color. These mites have piercing-sucking mouthparts and feed on the outermost plant cells. Eriophyid mite feeding can cause a silvering or bronzing of leaf foliage, and heavy infestations may lead to premature defoliation.

Biology and life history These mites overwinter as diapausing females in buds immediately under the bud scales, or in cracks along the bark. As buds expand in the spring, females leave their overwintering sites and begin feeding, then after a few days lay eggs. In the spring, eggs may take two weeks to hatch, but by midsummer they may hatch in as little as 3 to 4 days. There are several generations per year. As the foliage deteriorates in late summer, diapausing females are produced.

Pest monitoring Typically when crop damage by these mites is detected, the best plan is to monitor and manage this pest the following spring. Observe the leaves for signs of mite feeding and use a hand lens to check for the mites, particularly in fruit trees with a history of eriophyid mite infestations.

Management—biological control

Phytoseiid predator mites almost always keep these mites under control when broad-spectrum insecticide applications are avoided. Rust mites form a significant food source for these predator mites that also control spider mite pests, so early-season populations of this eriophyid mite should be tolerated. Hot, dry weather and the hardening off of leaves can reduce eriophyid mite numbers.

Management—chemical control

Successive sampling during the dormant, delayed-dormant period or early spring can best target pesticide applications towards active and growing populations of eriophyid mites before mite damage causes leaf bronzing or silvering. Do not apply these products after the damage has been done.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the tree thoroughly, including small limbs. Apply during the dormant, delayed-dormant period.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

- carbaryl—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A. REI 12 hr. PHI 7 days. Limited to one application per season.

Peach and nectarine—Leafroller

Includes
European leafroller (*Archips rosana*)
Fruittree leafroller (*Archips argyrospila*)
Obliquebanded leafroller (*Choristoneura rosaceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage There are several species of leafroller pests in tree fruits. The larvae of these moth species use native ornamental plants as well as fruit trees as hosts. They all cause similar damage to the trees, but differ in their appearance and, more importantly, in their life cycle. The principal leafroller pests of fruit trees are divided into single-generation moths such as the fruittree leafroller and the European leafroller, and two-generation moths such as the obliquebanded leafroller and pandemis leafroller.

Adults of these species vary in color, ranging from fawn-colored to dark brown. There are distinctive bands or mottling on the wings. Wingspans range from 0.5 to 1inch. The larvae of these species are all green caterpillars with a light brown to black head, depending on the species. Mature larvae may measure 0.75 to 1-inch long. Larvae roll and tie leaves together for shelter and feeding on the leaves. Feeding on growing points on young plants can promote undesirable branching. Newly hatched larvae may work into blossoms and damage developing fruit, which then abort and fall off the tree. Larvae of the summer generation of pandemis and obliquebanded leafroller may feed on the surface of fruit just before harvest.

Biology and life history The single-generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring as buds are opening until petal fall. The larvae feed for 4 to 6 weeks, then pupate in the rolled leaves and emerge as moths in early summer. The overwintering eggs are laid in July.

Two-generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants. Larvae may feed during warm periods in winter but become most active in spring with onset of new growth. They feed for several weeks and then pupate in rolled leaves. Adult moths emerge in late April to May, mate and then lay eggs for the second generation. These larvae hatch in early summer and do the most fruit damage.

Pest monitoring Observe early spring growth for rolled leaves and feeding damage on new growth. There are species-specific pheromone lures

available for commercial growers for leafroller moths. Traps baited with these lures are effective in monitoring moth flight periods and timing spray applications. Note that trap catch numbers are not always correlated with fruit damage at harvest.

Management—biological control

Very low temperatures in winter and late spring frosts can significantly reduce overwintering populations of larvae. Spiders and parasitic wasps, as well as predators like lacewings, greatly reduce leafroller populations throughout the year.

Management—cultural control

Hand-pick rolled leaves containing larvae or pupae. Removal of overwintering sites, such as dropped and rolled leaves on the ground or leaves plastered to tree trunks, can reduce next year's population.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the entire tree thoroughly including small limbs. Apply only during dormant or delayed-dormant period.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Not recommended for use on yellow-skin nectarine varieties. Some formulations OMRI-listed for organic use.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

For orchards with a history of leafroller problems, direct cover sprays in the early spring at the overwintering generations for best control. Summer generations of leafrollers become more difficult to control.

Petal fall, spring and summer sprays

- *Bacillus thuringiensis* var. *kurstaki*—Check label for rates. REI 4 hr. PHI 0 days. Nontoxic to bees. This biologically derived material is slow acting and requires good coverage and multiple applications in order to be effective. Apply when forecast calls for warm daily temperatures. This material is less effective during cool weather when larvae are not actively eating. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Altacor 35WDG) at 3 to 4.5 oz/A. REI 4 hr. PHI 10 days.
- flubendiamide + buprofezin (Tourismo) at 10 to 14 fl oz /A. REI 12 hr. PHI 14 days.
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- spinetoram (Delegate 25WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Resistance management Leafrollers can develop resistance rapidly to chemical controls. Do not treat consecutive generations with pesticides representing the same chemical group or mode of action. Spinetoram and spinosad are group 5 products. Chlorantraniliprole and flubendiamide are group 28 products.

Peach and nectarine—Lygus bug and stink bug

Includes
Lygus bug (*Lygus* spp.)
Brown marmorated stink bug (*Halyomorpha halys*)
Stink bug (several species)

See also:

Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

Pest description and crop damage Lygus bugs are small, semi-oval bugs. Adults are 0.15 to 0.2 inch long, brown, green, gray, or almost black with a yellow "V" on the back. They may feed on and damage fruit and blossoms. Stink bugs are gray, brown, or green, and are shield-shaped; they are about 0.5 to 0.7 inch long. These bugs pierce fruit with their mouthparts and siphon out tissue fluids. This feeding damage causes dimpling, sunken

spots on young fruit and can deform mature fruit (often referred to as cat-facing). Interior fruit damage appears as white, corky areas. These bugs have an extremely wide host range that includes field and vegetable crops, hay crops, natural vegetation in uncultivated land and weeds in adjacent areas. These pests do not reproduce on tree crops, but invade from outside hosts, or from orchard ground cover.

Biology and life history Adults typically overwinter in groundcover. They feed early in the season on weeds and later may move into fruit tree canopy. Stink bug damage is worse in dry summers when alternative hosts are dried up.

Pest monitoring Periodically scout fruit trees for the presence of adult lygus and stink bugs particularly in trees with a history of bug damage to the fruit. Critical times to scout are when the adjacent weed hosts are drying up or when nearby host crops are being harvested.

Management—cultural and biological control

When possible, do not plant peach or nectarine trees adjacent to hay fields, weedy lots, or uncultivated land. Proper weed management early in the season can reduce the attractiveness of an orchard to these pests. DO NOT mow orchard floor within two weeks prior to fruit harvest as any bug infestation in the ground cover will move to the tree canopy.

Management—chemical control

Spray applications, primarily pyrethroid products, target adult bugs. Spray residue contacts and intercepts lygus and stink bugs as they move between outside host source and fruit tree. Use of the pyrethroid products may result in increased problems with spider mites.

Management—chemical control: HOME USE

- acetamiprid—Stink bug only. Toxic to bees.
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate-—Highly toxic to bees.
- gamma-cyhalothrin-—Highly toxic to bees.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Stink bug only. Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin-—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant and delayed-dormant sprays

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. Extremely toxic to fish and wildlife; avoid spray drift and runoff to surface waters.

Spring and summer sprays

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.3 to 2.5 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and runoff to surface waters.

Peach and nectarine—Oriental fruit moth

Aspila (*Grapholita*) *molesta*

Pest description and crop damage Adult is a greyish brown moth with a wingspan of around 0.5 inch. Larvae are pinkish and between 0.4 to 0.5 inch long when fully grown. Larvae tunnel within twigs and cause tips to wilt. This damage can be confused with peach twig borer but can be distinguished by observing the features of mature larvae. There are multiple generations each growing season. In later generations, larvae can attack the fruit, often by boring through the stem end into the fruit.

Biology and life history This insect overwinters as fully grown larvae in a hibernaculum (enclosed within a silk webbing) in ground cover or tree crevices. In spring, pupation occurs, and adults appear near bloom. Eggs are laid on foliage and the larvae feed by boring into the growing shoots. There may be 3 to 4 generations per year. Later generations also attack fruit before seeking overwintering sites.

Pest monitoring Distribution of this pest appears to be spotty in the Pacific Northwest with isolated populations found primarily in neglected backyard fruit trees. In fruit trees with a confirmed history of Oriental fruit moth infestations, scout fruit trees in early spring for wilted leaves at shoot and twig tips. Monitoring traps baited with Oriental fruit moth pheromone can be used to detect the absence/presence of this pest in your area and help better time pesticide applications.

Management—biological control

Dispensers containing synthetic insect pheromone may be used to disrupt Oriental fruit moth mating. Pheromone mating disruption works best in large orchard blocks and is not considered an option for backyard fruit trees. Expert advice and careful monitoring are necessary to use this product successfully.

Management—chemical control

Spray applications and pesticide residues must be well-timed to contact the newly-hatched larvae before they bore into the shoot or fruit.

Management—chemical control: HOME USE

- acetamiprid
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring applications

Dispensers must be in the orchard before adults begin flying in spring. Place dispensers in the upper one-third of the tree or higher. Some formulations are OMRI-listed for organic use.

- CheckMate OFM Dispenser at 100 to 200 dispensers/A. Some dispensers are OMRI-listed for organic use.
- Isomate OFM/PTB TT at 100 to 200 dispensers/A. Some dispensers are OMRI-listed for organic use.

Spring and summer sprays

Multiple sprays are necessary to control this pest because it has three to four generations per year. Apply sprays based on pheromone trap catches or apply at petal fall, again 10 to 12 days later, and a third time about mid-June.

- acetamiprid (Assail 70WP) at 2.3 to 3.4 oz/A. REI 12 hr. PHI 7 days.
- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A. REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- chlorantraniliprole (Altacor 35 WDG) at 3 to 4.5 oz/A. REI 4 hr. PHI 10 days.
- flubendiamide/buprofezin (Tourismo) at 14 fl oz /A. REI 12 hr. PHI 14 days.
- methoxyfenozide (Intrepid 2F) at 10 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- phosmet (Imidan 70-W) at 2.13 to 4.25 lb/A. Do not exceed 4.25 lb/A. REI 7 days. PHI 14 days. Not to exceed 4.25 lb product or 3 lb ai/A per year. REI 7 days. PHI 14 days. Extremely toxic to fish; avoid spray drift and runoff to surface waters.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Peach and nectarine—Peachtree borer

Synanthedon exitiosa

Pest description and crop damage The adult male is a steel-blue, clear-winged moth with an approximately 1-inch wingspan. The female is similar in appearance but has smoky-colored wings and an orange band around her abdomen. Adult flight is usually from late June through September and eggs are laid at or on the base of the fruit tree. Larvae burrow in the crown and roots, girdle young trees, and weaken others. A single larva can girdle a newly planted fruit tree. Larval presence can best be detected by globs of gum mixed with a granular brown frass (excrement) that appear at the base of infested fruit trees. Full-grown larvae are 1.0 to 1.4 inch long with a whitish body and a brown head.

Biology and life history The borer overwinters as a larva under the tree bark, usually below the soil surface. As temperatures rise above 50°F in the spring, the larva resumes feeding on the tissues under the bark. Larvae reach maturity in May to June and pupate in trees. Adult moths emerge beginning in June and continue to emerge through September. Mating and egg laying occurs throughout this period. The young larvae hatch after 8 to 10 days and immediately bore into the base of the tree. Larvae in the bark above the soil surface usually do not survive the winter in cold areas.

Pest monitoring Periodically scout the base of the trunk near the soil surface for excessive gummosis mixed with granular frass. Pheromone traps are available to monitor adult male moth activity.

Management—cultural control

Protect the base of the fruit tree from larval entry by placing a plastic or metal cone or barrier around it before egg laying begins. The cone should be pushed one to two inches into the soil and should fit snugly around the trunk at the top to prevent the tiny larvae from getting beneath it. Alternatively, if there are only one or a few peach trees in a home orchard, it may be quicker and cheaper to control this insect by "worming." Use a pocketknife, wire, or some pointed instrument to remove dirt around the tree and dig out the larvae.

Management—chemical control

Spray applications, and more importantly pesticide residues, on the trunk of the tree can prevent newly-hatched larvae from boring beneath the tree bark and entering the woody trunk where they are protected from all insecticide sprays.

Management—chemical control: HOME USE

- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.

- gamma-cyhalothrin—Highly toxic to bees.
- lambda-cyhalothrin—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring applications

Dispensers must be in the orchard before adults begin flying, typically in late June. Place dispensers in the upper half of the tree. Some formulations are OMRI-listed for organic use.

- Isomate P Pheromone at 100 to 250 dispensers/A.

Spring and summer sprays

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Apply as directed trunk spray using thorough coverage. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- permethrin (Pounce 25WP) at 6.4 to 16 oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.

Peach and nectarine—Peach twig borer

Anarsia lineatella

Pest description and crop damage Peach twig borer is a European insect first found in California in the 1880s. It is a major pest of apricots, peaches, plums, and prunes. There are no known hosts outside the orchard. The adult is a gray moth with white and dark scales, about 0.33 to 0.5 inch long. The larva is a caterpillar. When mature the caterpillar is about 0.5 inch long, with a dark brown head and distinctive, alternating light and dark bands on the body. Larvae injure fruit trees by feeding on the buds and twigs early in the season, then the larvae bore into the shoots, causing a characteristic "flagging" or wilting of the new growth. Later generations of larvae feed within shoots or even on the fruit itself. Flagging of twigs indicates an infestation.

Biology and life history The borer overwinters as an immature larva in tunnels constructed in the crotches of twigs and branches. These overwintering sites can be identified by the small chimneys of frass (excrement) and wood chips produced by the feeding of the larvae. Larvae are active at the pink bud stage and feed on buds and young leaves before boring into a shoot. These larvae eventually leave the mined shoot to pupate. Adults then emerge in mid- to late May. Eggs are laid on fruit, shoots, or undersides of leaves. Eggs are yellowish white to orange. The eggs hatch, and these larva feed and mature on shoots and immature fruit. The next adult flight is in mid-July. Some of the larvae from this flight overwinter, the rest produce a partial third flight.

Pest monitoring Early in the spring, scout fruit trees for the new growth for flagging shoots that foreshadow a need to protect the fruit later in the season. Peach twig borer moths can be monitored with pheromone traps placed in the orchard by early May.

Management—chemical control

Early sprays aimed at the newly hatched larvae before they bore into the shoot, or fruit, will provide the best control of peach twig borer.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- acetamiprid—Toxic to bees.
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Delayed-dormant and prebloom sprays

Warning: These products are toxic to bees. Do not use them during bloom or if bees are foraging in the orchard.

- chlorantraniliprole (Altacor 35 WDG) at 3 to 4.5 oz/A. REI 4 hr.
- flubendiamide /buprofezin (Tourismo) at 10 to 14 fl oz /A. REI 12 hr.
- phosmet (Imidan 70-W) at 4.25 lb/A. REI 7 days. Extremely toxic to fish; avoid spray drift and runoff to surface waters.
- spinetoram (Delegate WG) at 3 to 7 oz/A. REI 4 hr.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Spring application

- Isomate OFM/PTB TT at 100 to 200 dispensers/A. Dispensers must be in the orchard before adults begin flying in spring. Place dispensers in the upper one-third of the tree or higher. Some formulations are OMRI-listed for organic use.

Spring and summer sprays

- *Bacillus thuringiensis* var. *kurstaki*—Check labels for rates. REI 4 hr. PHI 0 days. These products work best when temperatures exceed 50°F over 3 consecutive days. Some formulations may be OMRI-listed as organic.
- chlorantraniliprole (Altacor 35 WDG) at 3 to 4.5 oz/A. REI 4 hr. PHI 10 days.
- flubendiamide + buprofezin (Tourismo) at 10 to 14 fl oz /A. REI 12 hr. PHI 14 days.
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A. REI 4 hr. PHI 7 days.
- phosmet (Imidan 70-W) at 1.25 to 4.25 lb/A. REI 7 days. PHI 14 days. Not to exceed 4.25 lb/A or 3 lb ai/A per season. Extremely toxic to fish; avoid spray drift and runoff to surface waters.
- spinetoram (Delegate WG) at 3 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Peach and nectarine—Scale insect

Includes
European fruit lecanium scale (*Parthenolecanium corni*)
San Jose scale (*Quadraspidiotus perniciosus*)

Pest description and crop damage Lecanium scales are up to 0.2 inch across, reddish brown, and rounded. They resemble small helmets or bumps on branches, stems, and the underside of leaves. The crawlers are flat, oval, and pinkish brown. San Jose scale is a pest of all fruit trees and many ornamental and wild trees and shrubs throughout the U.S., particularly in hot, dry climates. San Jose scale can be differentiated from other scale insects by the scale (shell) that covers the adult females. The scale is hard, gray to black, cone-shaped and less than 0.1 inch in diameter. The scale has a tiny white knob in the center with a series of grooves or rings around it. Scales are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Severe infestations can kill twigs. Large quantities of honeydew are produced that may cause russeting on fruit and growth of sooty mold fungus.

Biology and life history Lecanium scale overwinters as an immature scale on twigs and branches. They resume feeding in the spring, and eggs are laid underneath the scales in May to June. The eggs remain under the scales until hatching in early summer. The young scales, called "crawlers," migrate to the undersides of leaves to feed. Young scales also can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After 4 to 6 weeks on the leaves, the young return to the stems and twigs to feed, mate, and overwinter. There is one generation per year. San Jose scale overwinters in an immature state and is black in color. In spring, the tiny, winged males emerge and mate with wingless females. Females give birth to live young about a month later (no eggs are produced). The young scales, called "crawlers," are very small, flattened, and yellow, and move around on bark and foliage before settling down to feed. A few days later, they secrete a waxy coating over their body that protects them from pesticides. From this point, female scales do not move. Crawlers are found during June and July and again in August to September, so there are two generations per year.

Pest monitoring Inspect twigs during the dormant season for scales. Pay particular attention to weak plants. Observe the young bark for purplish-red halos which indicate infestation. The crawlers are best observed during June to July with a 10X magnifying glass. Crawlers can be monitored by wrapping a piece of black sticky tape around an infested branch with the sticky side out.

Management—chemical control

The best time to control scale insects, such as the San Jose scale, is during the delayed-dormant period. These applications target and smother the non-motile overwintering adult and egg stages. If spring and summer scale control is required, apply during the crawler period (June and July).

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays using enough water to cover the tree thoroughly, including small limbs.

- horticultural mineral oil—Some formulations OMRI-listed for organic use.

Growing-season spray

- acetamiprid—Toxic to bees.
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin-—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Peach only. Soil drenches may have residual activity in woody plants lasting for twelve or more months. If short-term management is the goal, consider other approaches.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant and delayed-dormant spray

- horticultural mineral oil—Rates vary; check product label. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr.

Spring and summer sprays

- diazinon (Diazinon 50W) at 1 lb plus 2 to 3 gal dormant oil or 1 to 1.5 gal superior type oil per 100 gal water per acre minimum. Do not exceed 4 lb/A per year (2 lb ai/A per year). REI 4 days. PHI 21 days. Do not apply more than 4 lb product or 6 gal oil per acre. Apply only once during the dormant season. **Warning:** Diazinon is hazardous to bees. Do not use during bloom or if bees are foraging in the orchard.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 14 days. Pyriproxyfen is a growth regulator, with activity toward egg and immature stages only. Under heavy scale pressure, use the higher rate.

Peach and nectarine—Shothole borer

Includes
Ambrosia beetle (*Xyleborinus* spp.)
Shothole borer (*Scolytus rugulosus*)

Pest description and crop damage Shothole borers are small beetles that were introduced to North America and have been found in the PNW since the early 1900s. They are pests of forest trees, ornamental shade trees, and shrubs as well as fruit trees. Apple, pear, cherry, and plum are attacked. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees or infested woodpiles may be attacked. The adult shothole borer is a brownish black beetle are less than 0.1 inch long. The larvae are white, legless, and about 0.17 inch long. A similar wood-boring beetle, the ambrosia beetle, is about 0.1 inch long, dark brown or black, and covered with yellowish hairs. The larva is pinkish-white, legless, cylindrical, and 0.17 inch long when mature. Larvae and adults of both these species bore into the cambial and vascular tissues of trees, weakening them and causing wilting and dieback of individual stems and branches. Trunks and branches can be completely riddled with galleries.

Biology and life history Shothole borer overwinters as a larva in burrows beneath the bark of infested trees. They pupate within the tree, then adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. Then they tunnel into the tree, excavating galleries parallel to the wood grain. Adults mate and lay eggs along the gallery. The eggs hatch, and the larvae feed by tunneling at right angles to the main burrow, causing a characteristic pattern of damage. The burrows are filled with frass and increase in diameter as the larvae mature. After 6 to 8 weeks, the larvae pupate at the ends of the galleries, then emerge as adults starting in August. The many small, round exit holes this creates gives a "shothole" effect. There are two generations per year.

Ambrosia beetle overwinters as a mature larva, pupa, or adult in galleries in the tree. When spring temperatures exceed 65° F, the females become active, fly to susceptible hosts, and bore into the tree. Eggs are laid in the gallery, and as they develop, the female carefully tends them and cultivates ambrosia fungus for them to eat. The females usually remove excrement or wood dust from the tunnels, and this, along with the uniform width of the galleries, distinguishes them from other wood-boring beetles. Young adults can be found tightly packed in the galleries in midsummer, where they remain until the following spring. There is only one generation per year.

Pest monitoring Periodically scout tree trunks and lower branches for presence of adult beetles, particularly between June to July and between September and October. Examine branches in late spring for holes 0.08 inch in diameter that often ooze sap and sawdust. These beetles are particularly attracted to unhealthy trees.

Management—cultural control

Maintain trees in vigorous condition and avoid water stress or trunk sunburn. Borer attack usually indicates that trees are stressed. Prune out shothole borer damaged limbs and destroy or burn all tree prunings that show signs of borer damage. Do not plant (or transplant) young fruit trees adjacent to wood piles, tree prunings, or other borer-infested trees.

Management—chemical control

Chemical controls are of limited value towards adults and ineffective towards larvae. Chemical controls can be directed towards adults as direct trunk or limb sprays when adult beetles are present.

Management—chemical control: HOME USE

- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

Check product labels for use on peaches.

- acetamiprid (Assail 30SG) at 8 oz/A. REI 12 hr. PHI 7 days.
- esfenvalerate (Asana XL) at 14.5 fl oz/A. REI 12 hr. PHI 14 days.

Peach and nectarine—Spider mite

Primarily

European red spider mite (*Panonychus ulmi*)
Twospotted spider mite (*Tetranychus urticae*)

Also includes

Brown mite (*Bryobia rubrioculus*)
McDaniel spider mite (*Tetranychus mcdanieli*)
Yellow spider mite (*Eotetranychus carpini borealis*)

For mite identification, see:

Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest

Pest description and crop damage All adult spider mites are small, usually only about 0.02 inch long and have eight legs. The various apple-infesting species vary in appearance as follows:

Brown mite: The adult female is dull reddish brown with dark orange markings, and somewhat flattened. The front legs are very long, over twice the length of the other legs, and extend forward from the body.

European red spider mite: Adults are globular, reddish with white spines. Immature mites are similar in appearance, only smaller. Eggs are red and globular.

Twospotted and McDaniel spider mite: Adults are yellowish-brown, about 0.02 inch long. Twospotted mites have two dark spots on the body, while McDaniel mites have four. Immature mites are similar in appearance, only smaller. Eggs are round and translucent to opaque.

Yellow spider mite: Adult females are pale yellow to white with 2 or 3 dark, rectangular markings on each side of the abdomen. Immature mites are similar in appearance to the twospotted spider mite but have more of a yellowish color. Eggs are clear and spherical.

These spider mites damage tissues by puncturing individual plant cells, then sucking the contents out of the cell. The damage appears as small yellow-white spots on the upper leaf surface. In heavy infestations, the spots coalesce and the leaf yellows or bronzes.

Biology and life history Twospotted, McDaniel and yellow spider mites overwinter as fertilized females under bark or in soil debris. European red mite and brown mites overwinter as eggs in crevices of twig bark and young limbs. They move to young foliage when buds break in spring and produce many generations during spring to autumn. Females can lay up to 10 eggs per day and more than 200 during their lifetime. Egg-to-adult development can occur in 7 to 10 days during summer. Spider mites thrive under hot, dry conditions. Large colonies of mites produce webbing along leaf midrib. Mite dispersal occurs mainly through wind transport.

Pest monitoring Periodically, scout fruit trees for the presence of stippled or yellowing leaves as mite damage can be easier to detect than the mites themselves. Observe the underside of leaves, particularly along the leaf midrib, for mites, mite eggs and webbing and check for the number of pest and predator mites. Sufficient control usually is achieved by midsummer by natural enemies if broad-spectrum insecticide application are avoided.

Management—biological control

Spider mite populations are reduced by cool, wet conditions early in the season. Considerable natural control is provided by lady beetles (*Stethorus* spp.) and minute pirate bugs (*Orius* spp.). Predator mites such as *Typhlodromus* spp. or *Neoseiulus fallacis* are also effective at managing populations of spider mites and can be purchased to augment populations. Avoid pyrethroid sprays during the growing season.

Management—cultural control

Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. The use of cover crops also reduces dust and mite problems. However, broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Mites may be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control: HOME USE

Note: Spider mites can rapidly develop resistance to chemical controls.

Dormant-season spray

- horticultural mineral oil (European red mite only)—Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use.
- gamma-cyhalothrin
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Avoid spraying when blossoms are present. Complete coverage, especially undersides of leaves, is essential. Not recommended for use on yellow-skin nectarine varieties. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use

- sulfur—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Dormant to delayed-dormant spray

- horticultural mineral oil—Rates vary; check product label. REI varies; check product label.

Spring and summer sprays

- bifenazate (Acramite 50WS) at 0.75 to 1 lb/A. REI 12 hr. PHI 3 days. Do not exceed one application per season. Primarily active towards the motile stages of mites but has some ovicidal activity.
- clofentezine (Apollo SC) at 4 to 8 oz/A. REI 12 hr. PHI 21 days. Apply only once per season and at first sign of egg deposition. Clofentezine and hexythiazox are primarily mite ovicides and will not control adult mites.
- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb/A. REI 48 hr. PHI 14 days. Do not exceed two applications or 3 lb/A per season. Apply when mites first appear.
- hexythiazox (Savey 50DF) at 3 to 6 oz/A. REI 12 hr. PHI 28 days. Apply only once per season and at first sign of egg deposition. Hexythiazox and clofentezine are primarily mite ovicides and will not control adult mites.
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A. REI 12 hr. PHI 7 days. Only one application per crop season. Apply when mites first appear.

Resistance management Spider mites can rapidly develop resistance to chemical controls. Clofentezine and hexythiozox have a similar mode of action and should not be applied to the same crop In any one year.

Peach and nectarine—Spotted-wing drosophila

Drosophila suzukii

For pest description, crop damage, biology, life history, sampling and cultural management

See:

Spotted-wing Drosophila: An Emerging Berry and Stone Fruit Pest

Management—chemical control: HOME USE

Spring and summer sprays

- acetamiprid—This product has shown inconsistent control of SWD in field trials.
- azadiractin (neem extract)—Some formulations are OMRI-listed for organic use. This product has been shown to provide some control of SWD.
- insecticidal soap—Avoid spraying when blossoms are present. Complete coverage, especially undersides of leaves, is essential. Not recommended for use on yellow-skin nectarine varieties. Some formulations are OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. These products have been shown to provide good control of SWD but have no residual activity.
- spinosad—Some formulations are OMRI-listed for organic use. This product generally provides good to excellent control and 5-7 days of residual activity.
- zeta-cypermethrin—This product has been shown to provide excellent control of SWD.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- diazinon (Diazinon 50W) at 4 lb/A. REI 4 days. PHI 21 days. Do not apply more than 4 lb product or 6 gal oil per acre. Apply only once during the dormant season. Maximum of one in-season foliar application regardless of target pest.
- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.3 to 2.5 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- malathion (Malathion 57EC) at 2 pints/A. REI 24 hr PHI 7 days.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Peach and nectarine—Western flower thrips

Frankliniella occidentalis

Pest description and crop damage Adult thrips are yellowish brown to straw colored and about 0.04 to 0.08 inch long. Nymphs resemble adults but are smaller and lack wings. Thrips feed on the fruit surface and often cause only cosmetic damage to developing fruit which appears as a surface stippling (microscopic, little white dots) or as a surface russet at harvest. Sometimes, the stippling may manifest itself on the fruit surface where multiple fruits or leaves contact each other. Nectarine is more susceptible than peach to thrips damage. Often thrips develop and overwinter on hosts outside the orchard; thus, their damage is heaviest in the perimeter rows.

Biology and life history Western flower thrips overwinter as adults in ground duff. Thrips usually emerge early, about popcorn stage. In the spring they seek out flowers where they feed on pollen and nectar and lay eggs into floral parts. The larvae feed on surface tissues of flowers, buds, and leaves. When mature, the larvae drop to the ground and pupate. The adults that emerge may lay eggs on developing fruit. Under favorable conditions, a complete life cycle may be completed in two weeks. There are several overlapping generations per year. Seasonal migration occurs at various times of the year due to destruction or drying up of host plants, and adjacent crops may be invaded by these insects. Thrips eat pollen and nectar on a wide range of plants (at least 244 species from 62 families).

Pest monitoring In fruit trees with a history of thrips damage to fruit in previous seasons, thrips abundance during flower bloom can be monitored by destructively sampling flowers and searching for the adult and immature thrips. Yellow sticky traps can also be utilized to sample thrips. Scouting can be focused on perimeter fruit trees or in areas within the orchard with a history of thrips damage to fruit.

Management—chemical control

The best means of controlling thrips is by intercepting them as they move into the orchard or by applying products after petal fall to try to kill the thrips under the peach or nectarine shuck.

Management—chemical control: HOME USE

Petal fall spray

- acetamiprid—Toxic to bees.
- azadiractin (neem oil)—Some formulations are OMRI-listed for organic use.
- gamma-cyhalothrin-—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—May require several applications. Complete coverage is essential. Not recommended for use on yellow-skin nectarine varieties. Some formulations are OMRI-listed for organic use.
- kaolin clay (Surround at Home)—Repels some insect pests when applied as a spray to leaves, stems, and fruit. OMRI-listed for organic use.
- lambda-cyhalothrin-—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against thrips. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin-—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Petal fall spray

- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust 80W) at 1.25 to 2.5 oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. OMRI-listed for organic use. May act slowly.

Pear Pests

Ashley Thompson, Chris Adams, and Heather Stoven

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INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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.

All rates listed are for formulated products, unless specifically stated otherwise. Products which are pre-packaged mixtures of insecticides are not recommended for use.

Protect pollinators: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard. For further information, see How to Reduce Bee Poisoning from Pesticides.

Mite identification: See Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest.

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

Pear—Aphid

Includes
Apple aphid (*Aphis pomi*)
Apple grain aphid (*Rhopalosiphum fitchii*)
Spirea aphid (*Aphis spiraecola*)

Pest description and crop damage All these aphids are light green in color. Spirea aphid is very difficult to separate from apple aphid without high magnification, whereas apple grain aphid can be distinguished by a yellowish green stripe down the middle of the back. Apple grain aphids infest pear only in the early part of the season, while apple aphid is present all summer. Aphids suck plant sap and live in colonies on new shoots. Populations are damaging only sporadically. Damage appears as rolled leaves, stunted terminal growth, and spotting from excreted honeydew.

Biology and life history Aphids overwinter as eggs in crevices and twigs. The eggs hatch near budbreak, and the nymphs feed on the underside of the leaves. After two to three generations, winged forms are produced that migrate to summer hosts, which include weeds, ornamental plants, and vegetables. After several more generations, the winged forms migrate back in the fall to the fruit tree to mate and lay the overwintering eggs.

Pest monitoring Begin observing shoots before budbreak, as management is best undertaken early while the aphid populations are small.

Management—biological control

Aphids have many natural enemies which include parasitic wasps, lady beetles, syrphid fly larvae, and green lacewings. Avoid broad-spectrum insecticide applications which disrupt these biological controls.

Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth.

Home orchardists: Wash aphids from plants with a strong stream of water or by hand-wiping.

Management—chemical control: HOME USE

.Dormant-season spray

- superior-type oil—Do not apply after delayed-dormant. Apply with enough water to cover the entire tree thoroughly. Some formulations are OMRI-listed for organic use.

Growing-season spray

- acetamiprid—Toxic to bees.

- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use
- *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- imidacloprid—Soil drenches may have residual activity in woody plants lasting for 1twelve or more months. If short-term management is the goal, consider other approaches. Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- acetamiprid (Assail 70WP) at 1.1 to 1.7 oz/A. REI 12 hr. PHI 7 days. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days. Do not exceed 0.60 lb ai (13.5 oz product) /A per calendar year. Repeated use may induce spider mite buildup.
- clothianidin (Belay) at 4 to 6 fl oz/A. REI 12 hr. PHI 7 days. Only apply post-bloom. Do not exceed 12 fl oz/A per year. Repeated use may induce spider mite buildup.
- diazinon (Diazinon 50W) at 1 lb/100 gal water (100 gal/A minimum). REI 4 days. PHI 21 days. Diazinon is no longer effective in some parts of Washington. Apply as a cover spray when infestation occurs. Applicators must use an enclosed cab, see label for details. One dormant and one in-season foliar application allowed.
- flonicamid (Beleaf 50SG) at 2 to 2.8 oz/A. REI 12 hr. PHI 21 days. Do not exceed three applications per season.
- imidacloprid (Prey 1.6) at 8 fl oz/A. REI 12 hr. PHI 7 days. Apply post-bloom. Repeated use may induce spider mite buildup.
- sulfoxaflor (Transform 50WG) at 0.75 to 1.5 oz/A. REI 24 hr. PHI 7 days. Do not apply between 3 days prior to bloom and until after petal fall.
- thiamethoxam (Actara) at 4.5 to 5.5 oz/A. REI 12 hr. PHI 35 days. Do not apply after pre-bloom (green cluster stage) or before post bloom (petal fall). Repeated use may induce spider mite buildup. Do not exceed a total of 11.0 oz/A (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam containing products per acre per growing season.

Pear—Armyworm and cutworm

Includes
Bertha armyworm (*Mamestra configurata*)
Spotted cutworm (*Xestia c-nigrum*)

Pest description and crop damage Several species of armyworms and cutworms attack tree fruits. The most serious pests of tree fruit in the PNW are the spotted cutworm and the Bertha armyworm. The adults are large moths ranging in color from gray to brown with spots on the wings. These moths are attracted to lights. Larvae are dirty white, reddish, gray, or black caterpillars up to two inches in length. The larvae of these moths feed on buds and leaves, chewing holes in buds and ragged holes out of leaves. They also feed on the growing tips, particularly on small trees or in high density plantings. On larger trees, most of the feeding will be on the lower branches and may be concentrated to a few stems or limbs, while other stems are undamaged. Best time for control is early in the season.

Biology and life history Weeds are the preferred source of food for these larvae, and eggs typically are laid on weeds in the ground cover around the trees. Depending on species, they may overwinter as pupae or larvae in the soil. The larvae spend the day in the soil, then climb up the tree during the night to feed, often following the same path.

Management—cultural control

Control weeds, grasses, and debris in the orchard that provide cover. Encourage natural enemies of cutworms like birds and spiders.

Home orchardists: Hand-pick cutworm larvae at night, using a flashlight to find them, if practical. Caterpillars can be trapped by tying plastic wrap tightly around branches and trunk, then applying Tanglefoot or a similar sticky material to the plastic wrap. Remove these in the fall.

Management—chemical control: HOME USE

- acetamiprid—Armyworm only. Toxic to bees.
- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki* (*Btk*)—Cutworm only. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to foliage, stems and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- Chemical control for armyworms and cutworms is generally not required in commercial pear orchards.

Pear—California pear sawfly

Pristiphora abbreviata

Pest description and crop damage The California pear sawfly should not be confused with the pear sawfly or pear slug *(Caliroa cerasi)*, which is also a sawfly, but whose larvae are slug-like. The larvae of the California pear sawfly look like caterpillars. They are bright green and about 0.5 inch in length. The larvae eat round holes in leaves and with extensive feeding only the midribs will remain. Although they do not directly attack fruit, they can defoliate a tree, or an orchard, in a matter of weeks. They are considered to be a minor pest of pear.

Biology and life history The insect overwinters as a pupa in the soil. In early spring the sawflies emerge and after mating the females lay eggs around the edges of leaves. Larvae emerge around petal fall and commence feeding. Their feeding leaves characteristic circular holes in the leaves, and also in the edges of the leaves in a pattern that resembles leafcutter bees. They continue feeding into May, at which time they fall to the soil to pupate and overwinter. There is only one generation per year.

Pest monitoring Observe trees for characteristic feeding damage early in the year.

Management—chemical control: HOME USE

- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Usually controlled by regular spray programs, but if high populations occur in organic pear orchards, application of spinosad (Entrust) has been found to provide control.

Pear—Campylomma bug

Campylomma verbasci

Pest description and crop damage *Campylomma*, or mullein bug, is Asian or European in origin. Adults are brownish-yellow and about 0.1 inch in length, very mobile and active. Nymphs are smaller, green, and also fast moving. The mature nymphs resemble aphids in some ways but are far more active. Feeding by nymphs causes dimpling and distortion of fruit although damage to pear is rare.

Biology and life history *Campylomma* females lay their overwintering eggs into crevices in the bark of the tree where the eggs lie dormant until spring. The eggs begin to hatch prior to bloom and developing nymphs can scar fruit with early feeding activity on the tiny maturing fruitlets. *Campylomma* remain on the tree host through the bloom period until late spring when they move to herbaceous host plants. *Campylomma* is also known as mullein plant bug, after one of its preferred herbaceous hosts, the weed common mullein. Weeds and crop plants such as potato, sugar beet, corn and small grains are also accepted herbaceous hosts. *Campylomma* feeds on the plant as well as preying on aphids and thrips while on the herbaceous host. Later in the season, adults move into the orchard to mate and lay eggs. Other than the brief window around bloom when fruit damage can occur, *Campylomma* is overwhelmingly a beneficial insect that helps manage aphids, mites, and psylla in the orchard. Monitoring populations early in the season is important for determining whether to apply treatments which are typically timed at prebloom or bloom (take precautions to protect pollinators). After this period, *Campylomma* cannot damage fruit and acts as a beneficial insect. Operators may find that it is cost-effective to hand thin the fruit that is damaged in the early season.

Pest monitoring Nymphs and adults may be monitored by limb tapping from the pink stage through petal fall.

Management—cultural control

Damaged fruit can be thinned.

Management—chemical control: HOME USE

There are no products registered for control of this pest in home garden pears.

Management—chemical control: COMMERCIAL USE

- Chemical control for *Campylomma* bug is generally not required in commercial pear orchards.

Pear—Codling moth

Cydia pomonella

Pest description and crop damage This insect can be the worst pest of pears, especially in warmer, dryer areas of the PNW. Adult moths have a 0.5 to 0.75 inch wingspan, with alternating gray and white bands on the wings and a copper band on the wing tips. Larvae are whitish with a black head when immature, and pinkish with brown heads when mature. Larvae are 0.1 inch long at hatch and 0.8 inch in length at maturity. Pupae are brown and about 0.75 inch in length. The eggs are small and usually laid singly. Larvae feed directly on the fruit by boring into it and feeding within. Minor damage "stings" can also occur, which are shallow depressions where feeding occurred and stopped. Larvae that bore into the fruit leave characteristic bore holes on the exterior, filled with frass which extrudes from the hole. Bartlett pears are the most susceptible to codling moth injury, especially early in the season. Most of the early season injury on pears will be through the calyx of the fruit. All pear cultivars become more susceptible to codling moth injury later in the season.

Biology and life history Codling moths overwinter as mature larvae in silken cocoons spun under loose bark on the tree, in the soil and detritus at the base of the tree, or on other surfaces such as fruit packing bins. Pupation takes place in the spring around the time the first blossoms are showing pink, and adults emerge around bloom. Adults are active only at dusk and dawn and lay eggs on leaves and fruit. The larvae emerge, begin feeding on fruit, and will bore to the center of developing fruit to feed on the flesh and seeds. As they mature, they push frass out of the entry hole. After three to four weeks, the larvae leave the fruit to seek a sheltered spot on the tree to spin cocoons. The larvae may overwinter in the cocoon, or they may emerge in two to three weeks as a new flight of adults. These adults are active in July and August. In warm areas, there may even be a third brood. Larvae of this brood often penetrate fruit but do not complete development before harvest or winter.

Pest monitoring Codling moth populations can be monitored using pheromone traps, and predicted with phenology models. Before the pink stage, place lure baited traps in the upper canopy of trees where you expect damage. Catches in the traps determine the biofix date, which is the first capture of multiple male moths (2-3) in a trap or consistent capture of multiple males over more than one trap. The biofix date is used as the point to start accumulating degree-days for the Stanley and Hoyt (1987) degree-day model, which is the best model for PNW locations south of 46°N. North of this latitude, the no-biofix model can be used (Jones et al. 2008).

Early season control of the first generation with oils or insecticides that target eggs and newly emerged larvae, is the most effective strategy for preventing population growth. This timing is around 250 degree-days after biofix. If mating disruption is used, monitor the orchard with traps baited with 10-mg pheromone lures or combination pheromone/pear ester lures set in the upper third of the canopy. Continue to monitor throughout the season. If more than five moths are captured in a trap over the first generation, check the orchard for fruit damage and, if needed apply a conventional insecticide. If fruit damage exceeds 0.1% at the end of the first generation, use conventional insecticides to control the second generation. The use of phenology models can help predict specific life stages and subsequent generations of the codling moth so that insecticides can be timed for the most susceptible life stage, which is after egg hatch and prior to larvae entering the fruit.

Management—cultural control

Black-light traps have shown some efficacy in small orchards for trapping the adult moths. Remove any infested fruit well before harvest, and destroy them to eliminate larvae. Remove brush and debris from the orchard, and remove bark scales from the tree to eliminate overwintering sites. Wrap the trunk with corrugated cardboard or burlap to trap migrating larvae. Periodic removal of these tree wraps to destroy cocooning larvae can help to reduce the population and limit subsequent fruit damage. Thinning fruit clusters to singles will aid in limiting codling moth entries.

Management—biorational control

Mating disruption is widely used as the foundation of integrated pest management strategies in commercial orchards. Hand applied dispensers (Isomate, No Mate, CheckMate, Disrupt) at 400 dispensers/Acre, or aerosol emitters (CheckMate Puffer, Isomate CM Mist) at one unit/Acre are the recommended rates to attain good control. Most formulations are OMRI-listed for organic use. Mating disruption is not effective when used in home orchards or on small plantings. A sprayable formulation for dispensing pheromone is also available (CheckMate CM-F).

Pheromone dispensers must be placed in the tree before first moth flight; this usually is around full bloom on Delicious apples. Place hand applied dispensers high in the top of the canopy. Aerosol emitters can damage leaves and fruit when pheromone formulation is sprayed directly onto tree.

If the orchard has a history of codling moth problems, use conventional insecticide sprays against the first generation. If a codling moth source exists nearby, use border sprays (five to six rows) of conventional insecticides.

Management—biological control

Codling moth granulosis virus (Cyd-X, Cyd-X HP, Virosoft CP4)—Check labels for rates. REI 4 hr. PHI 0 days. Most formulations are OMRI-listed for organic use. Granulosis virus, a selective biological insecticide, must be ingested to be effective. Thorough coverage is important. The virus degrades when exposed to UV light. Frequent applications (seven to fourteen days) may be necessary, especially when codling moth pressure is high. Sprays of *Bacillus thuringiensis* (*Bt*) have not proven effective.

Management—chemical control: HOME USE

After petal fall spray and spring and summer sprays

Apply first cover spray at 250 degree-days after biofix, or about ten days after full petal fall (all petals are off) or 17 to 21 days after full bloom. Insecticides must be timed to target newly hatched larvae before they bore into the fruit. Multiple sprays are often necessary with applications up to every 10 to 14 days, however sprays can be reduced by monitoring for adult moths with pheromone traps or the use of degree-day models to properly time insecticide applications to the hatching larvae during the growing season. In fruit growing regions, Extension offices may also have data on biofix dates.

- acetamiprid—Toxic to bees.
- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

In major fruit-growing areas, spray notices are sent from local Extension offices.

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A (0.075 to 0.15 lb ai/A). REI 12 hr. PHI 7 days. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days. Do not exceed 0.60 lb ai (13.5 oz product) /A per calendar year. Repeated use may induce spider mite buildup.
- chlorantraniliprole (Altacor) at 3 to 4.5 oz/A. REI 4 hr. PHI 5 days. Do not exceed 9 oz/A per season. Use 4 to 4.5 oz/A when codling moth pressure is high.
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A. REI 12 hr. PHI 3 days. Do not exceed three applications per season.
- diazinon (Diazinon 50W) at 1 lb/ 100 gal per A (100 gal/A min). REI 4 days. PHI 21 days. Apply as a cover spray when infestation occurs. Do not exceed one in-season foliar application per year. Applicators must use an enclosed cab, see label for details.
- diflubenzuron (Dimilin 2L) at 12 to 16 fl oz product in at least 80 gal water/A. REI 12 hr. PHI 14 days. Use against low to moderate pest pressure in conjunction with codling moth mating disruption. Adding 1% horticultural mineral oil to early season applications increases efficacy on codling moth. See label for application timing. Complete coverage is necessary for optimal control.
- indoxacarb (Avaunt 30WDG) at 6 oz/A. REI 12 hr. PHI 28 days. Apply in spray volume of 200 gal/A or less. Use against low to moderate pest pressure in conjunction with alternate control measures such as mating disruption.
- methoxyfenozide (Intrepid 2F) at 16 fl oz/A. REI 4 hr. PHI 14 days. Use against low to moderate pest pressure in conjunction with alternative control measures such as mating disruption. See label for application timing. Do not exceed 64 fl oz/A per season.
- novaluron (Rimon 0.83EC) at 32 fl oz/A. REI 12 hr. PHI 14 days. Do not apply after pear turn-down. For use on pears only in Colorado, Michigan, New York, Pennsylvania, Washington and Oregon.
- phosmet (Imidan 70W) at 3.5 to 5.75 lb/A. REI 7 days. PHI 7 days. Do not exceed 16 lb/A per season.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 45 days. Use against low to moderate pest pressure in conjunction with alternate control measures such as mating disruption. Adding 1% oil increases Esteem's efficacy on codling moth. See label for application timing. Do not exceed two applications per season.
- spinetoram (Delegate WG) at 1.5 to 1.75 oz/100 gal water (6 to 7 oz/A). REI 4 hr. PHI 7 days. Do not exceed four applications or 28 oz/A per season. Do not make over three consecutive applications.
- spinosad (Entrust SC) at 6 to 10 oz/A. REI 4 hr. PHI 7 days. Do not exceed 29 oz/A per year. OMRI-listed for organic use.

Resistance management Avoid treating consecutive generations of codling moth with the same material or materials with the same mode of action. Alternate pesticides with different chemistries and modes of action.

Pear—Cutworm

See:
Pear—Armyworm and cutworm

Pear—Eriophyid mite

Pear rust mite (*Epitrimerus pyri*)
Pearleaf blister mite (*Eriophyes pyri*)

Pest description and crop damage Adults of eriophyid mites cannot be seen without magnification. Pearleaf blister mites are light in color, cylindrical, tapered at the posterior end, with two pairs of short legs at the front of the body. The overall appearance is that of a small worm. Nymphs have the overall appearance of the adult, but are even smaller. Adult rust mites are wedge-shaped and yellowish brown with two pairs of legs near the front of the body.

Pearleaf blister mite feeding on leaves causes reddish to yellowish green blisters; blisters turn brown or black as the tissue dies later in the season. Leaves may drop prematurely. Loss of foliage weakens trees, reduces shoot growth, and interferes with fruit maturation and fruit bud formation. Feeding on fruit causes irregular, russeted spots. Feeding by pear rust mites on foliage causes bronzing of the leaves, while feeding on the fruit causes russeting, especially around the calyx end but can extend over most of the fruit. Non-russeted cultivars like Anjou and Bartlett are particularly susceptible.

Biology and life history Eriophyid mites overwinter as mature females under outer bud scales. As buds swell in the spring, the mites begin to disperse and will infest developing leaves and fruitlets. Several generations per year may develop, eventually the mites will move to growing terminals. Fruit damage by blister mites is caused by feeding injury to buds before bloom—mites do not reside in the blisters on fruit. Eriophyid mites move from tree to tree, perhaps by wind or carried on birds or insects.

Pest monitoring Scouting for pearleaf blister mite is not effective during the current season, as by the time blisters are noticed the damage is done. Plan on taking action the following fall or spring if damage is noted. If pear rust mites are observed at any time then control may be warranted to limit any further fruit russeting.

Management—chemical control: HOME USE

Dormant-season spray

- lime sulfur—Applications in the fall can significantly reduce populations of both these mites the following year. Application in the spring before bud swell can also be effective. Some formulations are OMRI-listed for organic use.
- superior oil—Apply as buds begin to swell. Some formulations are OMRI-listed for organic use.

Growing-season spray

- carbaryl—Highly toxic to bees.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Delayed-dormant spray

- lime sulfur (Calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil; see label for rates. REI 48 hr. Some formulations are OMRI-listed for organic use.
- micronized sulfur (Microthiol Disperss) at 10 to 20 lb/A. Apply with oil at labeled rates. REI 24 hr. If used after delayed dormant micronized sulfur may injure some varieties. Some formulations are OMRI-listed for organic use.

Growing-season spray for control of pear rust mite

- abamectin (Agri-Mek SC) at 2.25 to 4.25 fl oz/A. REI 12 hr. PHI 28 days. Use with an adjuvant; see label.
- carbaryl (Sevin SL) at 1.5 to 3 quarts/A. REI 12 hr. PHI 3 days. Application to pears <20mm in size may result in fruit thinning and deformed fruit.
- fenbutatin-oxide (Vendex 50WP) at 1.5 to 2 lb/A. REI 48 hr. PHI 14 days. Do not exceed two applications between petal fall and harvest.
- fenpyroximate (FujiMite SC) at 32 oz/A. REI 12 hr. PHI 14 days. Do not exceed one application per season.
- pyridaben (Nexter SC) at 11 to 17 oz/A. REI 12 hr. PHI 7 days. Apply as populations begin to build. Do not exceed one application per season.
- spirodiclofen (Envidor 2SC) at 18 oz/A. REI 12 hr. PHI 7 days. Do not exceed one application per season.
- spirotetramat (Ultor) at 8 to 14 oz/A. REI 24 hr. PHI 7 days. Minimum 14 days between applications. Must be used with an adjuvant; see label. Do not apply prior to petal fall.
- tolfenpyrad (Bexar) at 21 to 27 fl oz/A. REI 12 hr. PHI 14 days.

Post-harvest spray

- lime sulfur (Calcium polysulfide)—Formulations vary; see label for rates. REI 48 hr. Some formulations are OMRI-listed for organic use.
- micronized sulfur (Microthiol Disperss) at 10 to 20 lb/A + horticultural mineral oil at labeled rates. REI 24 hr. Some formulations are OMRI-listed for organic use.

Pear—Grape mealybug

Pseudococcus maritimus

Pest description and crop damage The adult female is wingless and can be up to 0.2 inch in length. It has a well-developed ring of waxy filaments around the sides of its body. The nymphs (or young crawlers) are purplish and covered with a powdery wax coating. As they get older, the coating gets thicker, and a fringe of wax filaments develops. Damage primarily results from the honeydew excreted by mealybugs. Honeydew is cast off in small drops and falls down through the canopy. When it lands on fruit it serves as a substrate for sooty mold which causes a coarse, black russet to form. This is similar to pear psylla russeting, though mealybug russeting is scattered over the fruit surface, while honeydew from psylla is in patches

or streaks. In addition to russeting due to honeydew, populations of mealybug can result in infestation of the calyx and associated rot in storage.

Biology and life history Grape mealybugs overwinter as eggs or first instar crawlers in egg sacs beneath bark scales and in cracks. Crawlers start emerging from egg sacs at the beginning of bud swell and begin feeding on the bases of buds. When buds open they go directly to new shoots and leaves. Once settled, the crawlers start feeding and become progressively harder to kill. First generation nymphs mature during late June and July in the Northwest. Adult males appear first, mate and die. Receptive females release a pheromone to attract males. Mated females migrate to sheltered areas, lay eggs and die in the egg sac. In warmer areas a second generation matures in late August and September. Nymphs of this generation sometimes settle around the stem end of the fruit or in the fruit calyx.

Management—biological control

Little research has been done to date on the effectiveness of natural enemies in keeping mealybug populations at levels below economic damage. Parasitic wasps, predatory bugs, predatory beetles, lacewings, and spiders can take a considerable toll on mealybugs in orchards that use fewer broad-spectrum chemicals. A ladybeetle, the "mealybug destroyer" (*Cryptolaemus montrouzieri*), is considered an effective predator of mealybugs worldwide. It is available from some insectaries.

Management—chemical control: HOME USE

- acetamiprid—Toxic to bees.
- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- pyrethrins—Some formulations are OMRI-listed for organic use. Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Usually, it takes two sprays to cover emergence (pink and petal fall). High volumes of water and thorough coverage are essential for control. Sprays applied when second-generation crawlers emerge in early July may help prevent fruit infestation in the calyx end.

- acetamiprid (Assail) at 1.1 to 3.4 oz/A. REI 12 hr. PHI 7 days. Do not exceed four applications or 13.5 oz per season. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days Repeated use may induce spider mite buildup.
- buprofezin (Centaur WDG) at 34.5 to 46.0 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications or 69 oz per season.
- diazinon (Diazinon 50W) at 1 lb/ 100 gal (100 gal/A min). REI 4 days. PHI 21 days. Apply as a cover spray when infestation occurs. Applicators must use an enclosed cab, see label for details. One dormant and one in-season foliar application allowed with a minimum of 70 days between applications.
- imidacloprid (Prey 1.6) at 20 fl oz/A. REI 12 hr. PHI 7 days. Only apply post-bloom. Repeated use may induce spider mite buildup.
- phosmet (Imidan 70W) at 3.5 to 5.75 lb/A. REI 7 days. PHI 7 days.
- spirotetramat (Ultor) at 10 to 14 oz/A. REI 24 hr. PHI 7 days. Minimum 14 days between applications. Must be used with an adjuvant; see label. Do not apply prior to petal fall.

Pear—Green fruitworm

Lithophane antennata and other fruitworm species

Pest description and crop damage Several species of green fruitworms can attack fruit trees. Adult fruitworm moths vary in appearance depending on the species but are generally large, with gray to reddish-brown wings, and are attracted to lights in the fall and spring. Immature larvae are similar to cutworms, with green bodies and heads. Mature larvae are green with white or cream longitudinal stripes. Green fruitworms can also be found feeding on a wide range of hosts such as willow, birch, alder, maple, and strawberry.

Green fruitworm larvae feed on flowers and leaves, occasionally tying them together with silk. When the larvae increase in size, they begin feeding on the fruit, starting inside the cluster and taking bites out of most fruit within the cluster. Badly damaged fruits drop, and damaged fruits that remain have large, russeted cavities.

Biology and life history Depending on species, the insect may overwinter as a pupa in the ground or as a fertilized female on the soil surface. In the spring, eggs are laid on the twigs, often before buds open. The eggs hatch at the pink stage, and young larvae feed on the flowers and leaves, and later on the leaves and fruit. When the larvae mature, they drop to the soil to pupate. Depending on species, they remain as pupae through the winter or emerge as adults in fall, mate, and the females overwinter.

Pest monitoring Examine fruit clusters shortly after fruit set for the small green larvae. They tend to occur in clumps, so thorough monitoring is required.

Management—biological control

Birds often are seen eating green fruitworm larvae. Ground predators probably reduce pupal or adult overwintering populations. Some parasitic wasps are also important.

Management—cultural control

Adults can be collected in black-light traps. Hand-pick larvae when thinning fruit.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.

- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- chlorantraniliprole (Altacor) at 2.5 to 4 oz/A. REI 4 hr. PHI 5 days. Do not exceed 9 oz/A per season.
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A. REI 12 hr. PHI 3 days. Do not exceed three applications per season.

Pear—Leafhopper

Rose leafhopper (*Edwardsiana rosae*)
White apple leafhopper (*Typhlocyba pomaria*)

Pest description and crop damage The most observed leafhopper in pears is the rose leafhopper, while the white apple leafhopper, a frequent pest of apples, is not commonly seen in pears. Leafhopper adults are pale in color, 0.12 inch in length with the wings held tentlike over the body. Nymphs are light green and may move rapidly if disturbed. Rose leafhopper nymphs have rows of black spots on the back. Adults and nymphs suck juices from leaves, causing stippling and mottling on leaves. Leafhoppers rarely cause enough damage in pears to warrant treatment.

Biology and life history The rose leafhopper overwinters on roses as eggs just beneath the bark. Adults will fly into pear orchards beginning in May and subsequent eggs are laid into leaf tissue. There are two or three generations per year.

Pest monitoring As a minor pest, monitoring is not necessary, although presence of the adults can be confirmed by early morning limb taps.

Management—biological control

Parasitic wasps exert some control over leafhopper populations.

Management—chemical control: HOME USE

Chemical control for leafhoppers is generally not required in home pear orchards.

Dormant-season spray

- superior-type oil—Some formulations OMRI-listed for organic use.

Growing-season spray

- acetamiprid—Toxic to bees.
- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations are OMRI-listed for organic use.
- imidacloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Chemical control for leafhoppers is generally not required in commercial pear orchards.

Pear—Leafroller

European or filbert leafroller (*Archips rosana*)
Fruittree leafroller (*Archips argyrospila*)
Obliquebanded leafroller (*Choristoneura rosaceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage There are several species of leafroller pests of tree fruits within the family Tortricidae. They all cause similar damage to the trees, but differ in their appearance and, more importantly, in their life cycle. The principal leafroller pests of fruit trees can be divided into single-generation moths, such as the fruittree leafroller and the European leafroller, and two-generation moths, such as the obliquebanded leafroller and pandemis leafroller. Adults of these species vary from fawn-color to dark brown. There are distinctive bands or mottling on the wings. Wingspans range from 0.5 to one inch. The larvae of these species are all green caterpillars with a light brown to black head, depending on the species. Pandemis larvae are green with a green or brown head. Obliquebanded leafroller larvae are similar to pandemis larvae, except the head is dark brown to black.

As the name leafroller implies, the larvae roll and tie leaves together for shelter and feeding. They thrash about when disturbed and may drop from the leaf suspended by a silken thread. Feeding on growing points on young plants can promote undesirable branching. Pre-bloom leafroller feeding within the cluster results in fruit abortion or deeply scarred fruit. Larvae also roll new leaves. Young larvae are tiny and notoriously difficult to sample, but they are typically most damaging because of feeding on developing fruitlets. The later life stages are evident as the caterpillars reach maximum size and the number of damaged leaves increases. Mature leafroller larvae often move to a new leaf just prior to pupation. By this point, any damage to fruit is complete and it is better to allow natural enemies to reproduce on the mature larvae than to attempt treating the population. A large complex of predators, parasitoid wasps, and parasitoid flies (Tachinidae) attack leafroller larvae.

Biology and life history The single-generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring as buds are opening until petal fall. The larvae feed for four to six weeks, then pupate in the rolled leaves and emerge as moths in early summer. The overwintering eggs are laid in July.

Two-generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants. Larvae may feed during warm periods in winter, but become active in spring with onset of new growth. They feed for several weeks, then pupate in rolled leaves. Adult moths generally emerge around May and lay eggs for the next generation. The next generation hatches in early summer and can cause considerable fruit injury as the larvae will settle and feed in fruit clusters especially where fruit are touching. Pandemis and obliquebanded leafrollers overwinter as larvae and have two generations per year. Fruittree and European leafrollers overwinter as eggs and have one generation per year. Eggs hatch in the prebloom period, and larvae mature by late May.

Pest monitoring Observe early spring growth for rolled leaves and feeding damage in fruit clusters and on new growth. Adults of these leafrollers may be monitored with pheromone traps to establish biofix for phenology models which have been developed for obliquebanded and pandemis leafrollers.

Management—biological control

Very low temperatures in winter significantly reduce overwintering populations of larvae. Spiders and parasitic wasps, as well as predators like the brown lacewing, greatly reduce leafroller populations throughout the year.

Management—cultural control

Fruit thinning can reduce problems significantly with some leafrollers. Thin fruit clusters to a single fruit. Hand-pick rolled leaves containing larvae or pupae.

Management—chemical control: HOME USE

Dormant-season sprays

Single-generation leafrollers that overwinter as eggs can be controlled with dormant oil sprays.

- superior-type oil—Some formulations OMRI-listed for organic use.

Growing-season sprays

- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.

- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- *Bacillus thuringiensis* var. *kurstaki* (Dipel, Javelin)—Check label for rates. REI 4 hr. PHI 0 day. This biologically derived material acts slowly and requires good coverage and multiple applications in order to be effective. Apply when forecast calls for warm daily temperatures. *Bt* is less effective in cool weather when larvae are not actively feeding. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Altacor) at 3 to 4.5 oz/A. REI 4 hr. PHI 5 days. Do not exceed 9 oz/A per season.
- cyantraniliprole (Exirel) at 10 to 17 fl oz/A. REI 12 hr. PHI 3 days. Do not exceed three applications per season.
- methoxyfenozide (Intrepid 2F) at 16 fl oz/A. REI 4 hr. PHI 14 days. Do not exceed 64 fl oz/A per season.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Do not exceed four applications or 28 oz/A per season.
- spinosad (Entrust SC) at 6 to 10 fl oz/A. REI 4 hr. PHI 7 days. Do not exceed 29 fl oz/A per year. OMRI-listed for organic use.

Resistance management Leafrollers can develop resistance rapidly to chemical controls. Alternate chemistries and modes of action.

Pear—Lecanium scale

Parthenolecanium corni

Pest description and crop damage This is a minor pest in commercial pear orchards. Adult scales are up to 0.2 inch across, reddish brown, and rounded. The adults resemble small helmets or bumps on branches, stems, and the underside of leaves. The crawlers are flat, oval, and pinkish brown. Scales are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Severe infestations can kill twigs. Large quantities of honeydew are produced, which causes russeting on fruit and growth of sooty mold fungus.

Biology and life history Lecanium scale overwinters in an immature state on twigs and branches. They resume feeding in the spring, and eggs are laid underneath the female (from May to June) where they remain until they hatch in early summer. The young scales, called "crawlers," migrate to the undersides of leaves to feed. Young scales also can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After four to six weeks on the leaves, the immatures return to the stems and twigs to feed, mate, and overwinter. There is one generation per year.

Pest monitoring Inspect twigs during the dormant season for scales. Pay particular attention to weak plants. The crawlers are best observed with a 10X magnifying glass, during May to July.

Management—biological control

Larvae of green lacewings and other insects, such as ladybeetles, are aggressive predators of lecanium scale.

Management—cultural control

Home orchardists: Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. Tanglefoot, "stickem," or a similar adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer or water applications, as this favors population increase.

Management—chemical control: HOME USE

Time chemical controls for either the overwintering scales or the crawlers.

Dormant-season spray

Apply sprays during dormant or delayed-dormant period (March to April). Do not use after pink appears in buds. Use enough water to cover all of the tree thoroughly, including small limbs and shoots.

- superior-type oil—Some formulations OMRI-listed for organic use.

Growing-season spray

Insecticide applications are aimed at the vulnerable crawlers, during mid-summer. Apply insecticides about ten days after full petal fall (all petals off) or 17 to 21 days after full bloom. Avoid applying insecticides to blooming plants in order to avoid bee injury. Follow all label directions.

- carbaryl

Management—chemical control: COMMERCIAL USE

Chemical control for lecanium scale is generally not required in commercial pear orchards.

Pear—Lygus bug and plant bug

Family Miridae, including
Lygus bug (*Lygus* spp.)
Western tarnished plant bug (*Lygus hesperus*)

Pest description and crop damage This group of insects have piercing-sucking mouthparts and a triangle between the head and the wings. Feeding on fruit causes depressions and hard corky areas. *Lygus* bug adults are 0.25 inch in length, green to brown.

Biology and life history These insects overwinter as adults and may migrate into orchards around bloom. *Lygus* bugs are especially problematic near alfalfa fields. *Lygus* bugs have a wide host range and will feed on many broadleaf weeds. As broadleaf weeds around orchards dry up during the summer, *Lygus* bugs may migrate into the orchard and feed on the fruit.

Pest monitoring Monitoring by limb tapping can aid in detection. A sweepnet can be used to sample the groundcover to determine if *Lygus* bugs are present. Damage to fruit is often the first indication of their presence in the orchard.

Management—cultural control

Establishment and maintenance of a weed-free orchard groundcover will deter *Lygus* bugs. A sod groundcover that is mowed regularly will minimize *Lygus* bug activity within the orchard. Eliminate border habitat or target management on border rows. Hand-thin damaged fruit.

Management—chemical control: HOME USE

- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- bifenthrin (Brigade 2EC) at 2.6 to 12.8 fl oz/A. REI 12 hr. PHI 14 days. Do not exceed 32 fl oz/A per season. Use of pyrethroid insecticides during the growing season can disrupt naturally occurring biological control and may result in increased populations of some pests.
- clothianidin (Belay) at 4 to 6 fl oz/A. REI 12 hr. PHI 7 days. Do not exceed 12 fl oz/A per season. Repeated use may induce spider mite buildup.
- diazinon (Diazinon 50WP) at 1 lb/100 gal (100 gallon minimum) plus 2 to 3 gal dormant oil or 1 to 1.5 gal superior type oil per 100 gal water. REI 4 days. PHI 21 days. Closed cab required. Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb of product or 6 gal of oil per acre. Apply only once during the dormant season.
- fenpropathrin (Danitol 2.4EC) at 16 to 21 fl oz/A. REI 1 day. PHI 14 days.
- flonicamid (Beleaf 50SG) at 2 to 2.8 oz/A. REI 12 hr. PHI 21 days. Do not exceed three applications per season.

Pear—Pearleaf blister mite

See:
Pear—Eriophyid mite

Pear—Pear leafcurling midge

Dasineura pyri

Pest description and crop damage This adult is a very small fly less than 0.1 inch in length. The larvae are very small, legless and orange in color when young, aging to white in color. The feeding of the larvae on leaves causes them to curl up along the midrib. Curled leaves have reddish-gall-like swellings and later on in the season turn black and fall off. Extensive feeding activity can stunt young trees, however in mature trees this is less of a pest. Pear leaf midge is seldom a problem in commercial pear orchards that receive a regular spray program. However, it can be a problem occasionally in the Willamette Valley and Hood River districts of Oregon.

Biology and life history The midge overwinters as a pupa in the soil. Around bloom the adults emerge and lay eggs in the leaves just as they are unfolding. The hatched larvae feed within the curled leaves, often numbering up to 30 larvae per leaf. When mature, the larvae chew an exit hole and drop to the ground to pupate. There may be several generations per year, the number depending entirely on the availability of new growth, as the adults lay eggs only on new foliage.

Pest monitoring Adults can be monitored with yellow sticky traps. Presence of the midge is also easily confirmed by the presence of the characteristic damage.

Management—chemical control: HOME USE

- acetamiprid—Toxic to bees.
- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- lambda-cyhalothrin—Highly toxic to bees.

- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Petal fall is the optimal treatment timing if chemical control is required.

- spirotetramat (Ultor) at 10 to 14 oz/A. REI 24 hr. PHI 7 days. Minimum 14 days between applications. Must be used with an adjuvant; see label. The product label lists pear leaf midge under pests suppressed. Do not apply prior to petal fall.

Pear—Pear psylla

Cacopsylla pyricola

Pest description and crop damage Pear psylla is one of the major pear pests in commercial orchards. The adult resembles a miniature cicada. Adults have two distinct forms, a summer and winter form, which differ in appearance. Winterform adults are 0.1 inch in length, dark in appearance, with transparent wings held roof-like over the body. Summerform adults are 0.08 inch long, greenish to brown, with a similar wing appearance to the winterform. The nymphs pass through five growth stages, each stage being larger, flatter, and more oval than the last. The first stage is creamy yellow, the last is dark green or brown. All stages have conspicuous red eyes. During the first three stages, the nymphs are encased in a drop of honeydew. Nymphs and adults suck plant juices, producing honeydew that drips onto leaves and fruit. This encourages growth of sooty mold, which causes russeting of the fruit. Blackening and burning of leaf tissue also is typical of psylla infestations. Large numbers of psylla can stunt and defoliate trees and cause fruit drop.

Biology and life history Pear psylla overwinter in a semi-dormant state as winterform adults on a variety of fruit trees. They return to pears and begin laying eggs at bud swell. The eggs are shaped like grains of rice and are yellow-orange at maturity. These are laid at the base of buds and in other rough places on small twigs. Egg laying continues for some time. Later eggs are laid along leaf midveins and petioles, and on stems and sepals of blossoms. The nymphs hatch and feed on the opening blossoms and young leaves, forming droplets of honeydew on both leaf surfaces. There may be two to three generations before the winter form generation appears in the fall.

Pest monitoring Monitor adults with a beating tray, the standard tray size is 18 inches x 18 inches. Place the beating tray under a limb and then tap the limb to knock the psylla adults onto the tray surface, usually made with white cloth. Check with a hand lens for eggs and nymphs on young shoots and leaves.

Management—biological control

A number of natural enemies attack psylla, including parasitic wasps, adults and larvae of lady beetles, lacewings, and earwigs, as well as predacious plant bugs and minute pirate bugs. If natural enemies are conserved within the orchard, biological control of this pest often can be significant.

Management—cultural control

Avoid promoting unnecessary vigor with excess nitrogen fertilizer. Remove suckers from the interior of the trees, which removes psylla eggs and nymphs and increases spray coverage.

Management—chemical control: HOME USE

Dormant-season spray

Use enough water to cover all of the tree thoroughly including small limbs and shoots. Spray timing can vary from early February to late March depending on location. Apply only during dormant or delayed-dormant period.

- lime sulfur mixed with superior-type oil—Some formulations are OMRI-listed for organic use.
- superior-type oil—Some formulations OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem extract)—If control is not satisfactory, add minimal rates of superior oil. Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant spray

- esfenvalerate (Asana XL) at 9.6 to 19.2 fl oz/A + horticultural mineral oil. REI 12 hr. Do not exceed 38.4 fl oz/A during dormant to pre-bloom stage.
- horticultural mineral oil at 1 to 2 gal/100 gal water or 4 to 8 gal/A. REI 12 hr. Used to delay egg laying. Some formulations are OMRI-listed for organic use.
- kaolin (Surround WP) at 50 lb/A. REI 4 hr. Used to delay egg laying. Apply enough spray to ensure thorough coverage. OMRI-listed for organic use.
- permethrin (Pounce 25WP) at 12.8 to 25.6 oz/A + horticultural mineral oil. REI 12 hr. Do not exceed 41.6 oz/A per season.

Delayed-dormant spray

The prebloom program is very important in preventing unmanageably high populations of psylla later in the summer. Areawide control has been very effective in commercial orchard regions.

- buprofezin (Centaur WDG) at 34.5 to 46 oz/A. REI 12 hr. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- lime sulfur (Calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil; see label for rates. REI 48 hr. Some formulations are OMRI-listed for organic use.
- diflubenzuron (Dimilin 2L) at 40 to 48 fl oz/A product + horticultural mineral oil at 1 to 1.5 gal/100 gal water. REI 12 hr.
- esfenvalerate (Asana XL) at 0.05 to 0.1 lb ai/A [7.3 to 12.8 fl oz/100 gal water (9.6 to 19.2 oz/A)] + horticultural mineral oil at 1 to 2 gal/100 gal water. REI 12 hr. Do not exceed 0.2 lb ai/A per season, 38.4 fl oz/A during dormant to prebloom stage.
- fenpropathrin (Danitol 2.4EC) at 16 to 21 fl oz/A. REI 1 day.
- kaolin (Surround WP) at 50 lb/A. REI 4 hr. Multiple applications are required for pear psylla control. Thorough coverage is important. OMRI-listed for organic use.
- lambda-cyhalothrin (Warrior II EC) at 1.3 to 2.5 fl oz/A. REI 1 day.
- lime sulfur at 11 gal/A or at 5 to 7 gal/A + horticultural mineral oil at labeled rates. REI 48 hr. Do not apply after delayed dormant. Some formulations are OMRI-listed for organic use.
- micronized sulfur (Microthiol Disperss) at 10 to 20 lb/A + horticultural mineral oil at labeled rates. REI 24 hr. Some formulations OMRI-listed for organic use.
- novaluron (Rimon 0.83EC) at 32 fl oz/A + horticultural mineral oil at 1 to 2 gal/100 gal water. REI 12 hr. Do not apply after pear turn-down. For use on pears only in Colorado, Michigan, New York, Pennsylvania, Washington and Oregon.
- permethrin (Pounce 25WP) at 12.8 to 25.6 oz/A + horticultural mineral oil. REI 12 hr. Do not exceed 41.6 oz/A per season.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. Do not exceed two applications per season.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. Do not make more than two applications for pear psylla in a season.

Prepink spray

Apply only if adult pear psylla density exceeds 0.2 per tray. These sprays do not replace the dormant or delayed-dormant sprays but should be used in addition to those sprays if needed.

- buprofezin (Centaur 70WDG) at 34.5 to 46 oz/A. REI 12 hr. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- cyantraniliprole (Exirel) at 13.5 to 20.5 fl oz/A. REI 12 hr. Do not exceed three applications per season.
- esfenvalerate (Asana XL) at 9.6 to 19.2 fl oz/A. REI 12 hr. Do not exceed 38.4 fl oz/A during dormant to prebloom stage.
- novaluron (Rimon 0.83EC) at 32 fl oz/A. REI 12 hr. Do not apply after pear turn-down. For use on pears only in Colorado, Michigan, New York, Pennsylvania, Washington and Oregon.
- permethrin (Pounce 25WP) at 12.8 to 16 oz/A. REI 12 hr. Do not exceed 41.6 oz/A per season.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. Do not exceed two applications per season.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. Do not make more than two applications for pear psylla in a season.

Pink spray

When 5% or more of the bud clusters are moderately infested (i.e., more than two pear psylla eggs or nymphs per cluster), treatment may be justified:

- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A. REI 12 hr. Do not exceed 0.60 lb ai (13.5 oz product) /A per calendar year. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days. Repeated use may induce spider mite buildup.
- buprofezin (Centaur WDG) at 34.5 to 46 oz/A. REI 12 hr. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- cyantraniliprole (Exirel) at 13.5 to 20.5 fl oz/A. REI 12 hr. Do not exceed three applications per season.
- fenpyroximate (FujiMite SC) at 32 oz/A. REI 12 hr. Do not exceed one application per season.
- novaluron (Rimon 0.83EC) at 32 fl oz/A. REI 12 hr. Do not apply after pear turn-down. For use on pears only in Colorado, Michigan, New York, Pennsylvania, Washington and Oregon.
- pyridaben (Nexter SC) at 17 to 25 oz/A. REI 12 hr. Higher rates are needed to control pear psylla. Registered SLN label for use in Oregon (24c SLN OR-170008). At these higher rates, PHI is 28 days. Do not exceed one application per season.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. Do not make more than two applications for pear psylla in a season.
- thiamethoxam (Actara) at 0.086 lb ai/A (5.5 oz/A). REI 12 hr. Repeated use may induce spider mite buildup. For pear do not apply Actara after pre-bloom (green cluster stage) or before post bloom (petal fall growth stage). Do not exceed a total of 11.0 oz/A (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam containing products per acre per growing season.

Petal fall spray

- abamectin (Agri-Mek SC) at 2.25 to 4.25 fl oz/A. REI 12 hr. PHI 28 days. Use with an adjuvant; see label.
- azadirachtin (Aza-Direct) at 1 to 3.5 pints/A. REI 4 hr. PHI 0 days. Do not use on comice or related pear varieties. OMRI-listed for organic use.
- buprofezin (Centaur WDG) at 34.5 to 46 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- cyantraniliprole (Exirel) at 13.5 to 20.5 fl oz/A. REI 12 hr. PHI 3 days. Do not exceed three applications per season.
- fenpyroximate (FujiMite SC) at 32 oz/A. REI 12 hr. PHI 14 days. Do not exceed one application per season.
- flupyradifurone (Sivanto 200 SL) at 10.5 to 14 fl oz/A. REI 4 hr. PHI 14 days. Combine with a horticultural oil for early season applications.
- novaluron (Rimon 0.83EC) at 32 fl oz/A. REI 12 hr. PHI 14 days. Do not apply after pear turn-down. For use on pears only in Colorado, Michigan, New York, Pennsylvania, Washington and Oregon.
- pyridaben (Nexter SC) at 17 to 25 oz/A. REI 12 hr. Higher rates are needed to control pear psylla. Registered SLN label for use in Washington (24c SLN WA-170002b) and Oregon (24c SLN OR-170008). At these higher rates, PHI is 28 days. Do not exceed one application per season.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. PHI 7 days. Do not make more than two applications for pear psylla in a season.
- spirotetramat (Ultor) at 10 to 14 oz/A. REI 24 hr. PHI 7 days. Do not exceed 40 oz/A per season. Minimum 14 days between applications. Must be used with an adjuvant; see label. Do not apply prior to petal fall.
- tolfenpyrad (Bexar) at 21 to 27 fl oz/A. REI 12 hr. PHI 14 days.

Growing-season spray

- abamectin (Agri-Mek SC) at 2.25 to 4.25 fl oz/A. REI 12 hr. PHI 28 days. Use with an adjuvant; see label. Effectiveness may be limited with late season applications.
- acetamiprid (Assail 70WP) at 1.7 to 3.4 oz/A. REI 12 hr. PHI 7 days. Do not exceed 0.60 lb ai (13.5 oz product) /A per calendar year. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days. Repeated use may induce spider mite buildup.
- azadirachtin (Aza-Direct) at 1 to 3.5 pints/A. REI 4 hr. PHI 0 days. DO NOT USE ON COMICE OR RELATED PEAR VARIETIES. OMRI-listed for organic use.
- buprofezin (Centaur WDG) at 34.5 to 46 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- clothianidin (Belay) at 6 fl oz/A. REI 12 hr. PHI 7 days. Do not exceed 12 fl oz/A per season. Repeated use may induce spider mite buildup.
- fenpyroximate (FujiMite SC) at 32 oz/A. REI 12 hr. PHI 14 days. Do not exceed one application per season.
- flupyradifurone (Sivanto 200 SL) at 10.5 to 14 fl oz/A. REI 4 hr. PHI 14 days. Combine with a horticultural oil for early season applications.
- imidacloprid (Prey 1.6) at 20 fl oz/A. REI 12 hr. PHI 7 days. Repeated use may induce spider mite buildup.
- kaolin (Surround WP) at 50 lb/A. REI 4 hr. PHI 0 days. Multiple applications are required for pear psylla control. Thorough coverage is important. OMRI-listed for organic use.
- pyridaben (Nexter SC) at 17 to 25 oz/A. REI 12 hr. Higher rates are needed to control pear psylla. Registered SLN label for use in Oregon (24c SLN OR-170008). At these higher rates, PHI is 28 days. Do not exceed one application per season.
- spinetoram (Delegate WG) at 6 to 7 oz/A. REI 4 hr. PHI 7 days. Do not make more than two applications for pear psylla in a season.
- spirotetramat (Ultor) at 10 to 14 oz/A. REI 24 hr. PHI 7 days. Do not exceed 40 oz/A per season. Minimum 14 days between applications. Must be used with an adjuvant; see label. Do not apply prior to petal fall.
- thiamethoxam (Actara) at 5.5 oz/A. REI 12 hr. PHI 35 days. Do not exceed a total of 11.0 oz/A (0.172 lb ai/A) of Actara or 0.172 lb ai of thiamethoxam containing products per acre per growing season.
- tolfenpyrad (Bexar) at 21 to 27 fl oz/A. REI 12 hr. PHI 14 days.

Post-harvest spray

- lime sulfur (Calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil; see label for rates. REI 48 hr. Some formulations are OMRI-listed for organic use.
- micronized sulfur (Microthiol Disperss) at 10 to 20 lb/A + horticultural mineral oil at labeled rates. REI 24 hr. Some formulations are OMRI-listed for organic use.

Resistance management Pear psylla can develop resistance rapidly to chemical controls. Resistance to insecticides has been documented in Oregon and Washington. Alternate chemistries and modes of action.

Pear—Pear rust mite

See:
Pear—Eriophyid mite

Pear—Pear sawfly (pear slug)

Caliroa cerasi

Pest description and crop damage Pear sawfly is a European insect now found in most areas of the U.S. It attacks both pear and cherry, and also is found on mountain ash, hawthorn, and ornamental *Prunus* spp. The adult is a glossy black about 0.2 inch in length. The larva initially resembles a small slug, due to the olive green slime that covers the body and the fact that the head is wider than the rest of the body. Mature larvae are 0.37 inch

in length and orange-yellow. Larvae feed on the upper surface of leaves, skeletonizing them, the fruit surface may also be scarred when populations are very high. Heavy feeding causes leaf drop with reduction in vigor, yield and return bloom, particularly on young trees.

Biology and life history Pear sawfly overwinters as a pupa in a cocoon two to three inches deep in the soil. Adults emerge over an extended period in late April to May. The adult female inserts eggs into leaf tissue, and eggs hatch in ten to fifteen days. Larvae immediately begin to feed on the upper surface of the leaf. After three to four weeks, they drop to the soil to pupate. Second generation adults emerge in July, and larvae from this generation feed in August and September. Most larvae from this generation drop to the ground to overwinter.

Pest monitoring Watch trees for the slug-like larvae especially in August and September when large populations can build up.

Management—cultural control

Home orchardists: Individual larvae can be picked off, or they can be washed off with a strong stream of water.

Management—chemical control: HOME USE

- esfenvalerate—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Usually controlled by regular spray programs but high populations can occur, particularly in organic pear orchards. Application of spinosad (some formulations are OMRI-listed for organic use) has been found to provide control.

- kaolin (Surround WP) at 50 lb/A. REI 4 hr. PHI 0 days. Thorough coverage is important. OMRI-listed for organic use.

Pear—Scale

Oystershell scale (*Lepidosaphes ulmi*)
San Jose scale (*Quadraspidiotus perniciosus*)

Pest description and crop damage San Jose scale was introduced to the U.S. on flowering peach in the 1870s. It is now a pest of all fruit trees and many ornamental and wild trees and shrubs throughout the U.S., particularly in hot, dry climates. Oystershell scale is European in origin and has been in the US since around 1850. San Jose scale can be differentiated from other scale insects by the scale (shell) that covers the adult females. The scale is hard, gray to black, and cone-shaped. The scale has a tiny white knob in the center with a series of grooves or rings around it. Oystershell scale looks like a miniature oyster. Oystershell scale is principally a pest of woody parts of the plant (although it occasionally attacks fruit), while San Jose scale attacks both woody parts and fruit. Scales are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Large populations of scale can devitalize plants and retard growth. Severe infestations by San Jose scale can kill twigs and even the whole tree. Large quantities of honeydew are produced, which makes leaves and fruit shiny and sticky. Sooty mold fungus may grow on this, giving the plants a dirty, sooty appearance. Fruit infestations by San Jose scale initially cause development of red spots around the feeding site.

Biology and life history San Jose scale overwinters in an immature state and is black in color. In spring, the tiny winged males emerge and mate with wingless females. Females give birth to live young about a month later (no eggs are seen). The young scales, called "crawlers," are very small, flattened, and yellow, and move around on bark and foliage before settling down to feed. Young scales also can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After settling down to feed, the insects become sessile and they secrete a waxy coating over their body that can protect them from pesticides. There are two generations per year, crawlers are usually found during June and July and again in August to September. Oystershell scale overwinters as eggs under the female scale, crawlers emerge in May and June and move to feeding sites on the bark. They secrete a waxy coating and the females remain sedentary. Males emerge from their coating and mate with the females, which lay eggs beneath their bodies, gradually shrinking in size and dying after the last eggs are laid. There is one generation per year.

Pest monitoring Inspect twigs and spurs during the dormant season for scales. Examine wood from the tops of trees and pay particular attention to weak plants. Observe the young bark for purplish-red halos which indicate infestation. The crawlers are best observed during June to July with a 10X magnifying glass. Crawlers can be monitored by wrapping a piece of double sided tape around an infested branch. Male San Jose scale can be monitored with pheromone traps. Adult males emerge in the spring around the same time as codling moth. Time in-season sprays to match crawler emergence.

Management—biological control

Larvae of green lacewings and other insects are aggressive predators of scale. A number of parasitic wasps will attack scale insects. However, biological control does not necessarily prevent significant scale infestations.

Management—cultural control

Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. Tanglefoot, "stickem," or a similar adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids and psyllids, avoid excessive nitrogen fertilizer, as this favors increased populations.

Management—chemical control: HOME USE

Dormant-season spray

Apply sprays during dormant or delayed-dormant period (March to April). Do not use after pink appears in buds. Use enough water to cover all of the tree thoroughly, including small limbs and shoots.

- superior-type oil—Some formulations are OMRI-listed for organic use.
- superior-type oil, plus either lime-sulfur or a lime-sulfur material such as polysulfide—Some formulations are OMRI-listed for organic use.

Growing-season spray

- acetamiprid—Toxic to bees.
- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Prebloom spray

- buprofezin (Centaur WDG) at 34.5 to 46 oz/A. REI 12 hr. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil.
- lime sulfur (Calcium polysulfide)—Formulations vary; see label for rates. May be mixed with horticultural mineral oil; see label for rates. REI 48 hr. Some formulations are OMRI-listed for organic use.
- horticultural mineral oil at 4 to 6 gal/A plus an organophosphate material such as diazinon. Check label for REI. Use only those chemicals and formulations that are registered and suggested for Pacific Northwest conditions. One dormant application is allowed. Applications of diazinon require an enclosed cab, see label for details. **Note:** Continual agitation is necessary when filling the spray tank and during spraying. Apply before new growth, at temperatures above 40°F, prior to hot or rainy weather or drying winds.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A + horticultural mineral oil at 4 to 8 gal/A. REI 12 hr. Do not exceed two applications per season.

Growing-season spray

- acetamiprid (Assail 70WP) at 3.4 oz/A. REI 12 hr. PHI 7 days. Will provide suppression. Do not exceed 4 treatments per calendar year. Do not apply more than once every 12 days. Do not exceed 0.60 lb ai (13.5 oz product) /A per calendar year. Repeated use may induce spider mite buildup.
- buprofezin (Centaur 70WDG) at 34.5 to 46 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications or 69 oz/A per season. Do not tank mix with oil
- diazinon (Diazinon 50W) at 1 lb plus 2 to 3 gal dormant oil or 1 to 1.5 gal superior type oil per 100 gal water. REI 4 days. PHI 21 days. Applicators must use an enclosed cab, see label for details. One dormant and one in-season foliar application allowed with a minimum of 70 days between applications. Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb of product or 6 gal of oil per acre. Apply only once during the dormant season.
- flupyradifurone (Sivanto 200 SL) at 10.5 to 14 fl oz/A. REI 4 hr. PHI 14 days. Combine with a horticultural oil for early season applications.
- imidacloprid (Prey 1.6) at 8 fl oz/A. REI 12 hr. PHI 7 days. Repeated use may induce spider mite buildup.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 45 days. Apply when scale crawlers first emerge. Do not exceed two applications per season.
- spirotetramat (Ultor) at 10 to 14 oz/A. REI 24 hr. PHI 7 days. Follow with a second application 14 to 21 days later. Do not exceed 40 oz/A per season. Minimum 14 days between applications. Must be used with an adjuvant; see label. Do not apply prior to petal fall.

Pear—Spider mite

Brown mite (*Bryobia rubrioculus*)
European red mite (*Panonychus ulmi*)
McDaniel mite (*Tetranychus mcdanieli*)
Twospotted spider mite (*Tetranychus urticae*)
Yellow spider mite (*Eotetranychus carpini borealis*)

***For mite identification**, see:*

Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest

Pest description and crop damage All adult mites are small, usually only about 0.02 inch in length and have eight legs. The various pear-infesting species vary in appearance as follows:

Brown mite: The adult female is a dull reddish brown with dark orange markings, and somewhat flattened. The front legs are very long, over twice the length of the other legs, and extend forward from the body.

European red mite: Adults are globular, reddish with white spines. Immatures are similar in appearance, only smaller. Eggs are red, globular and have a stripe.

Twospotted and McDaniel mite: Adults are yellowish-brown, about 0.02 inch in length. Twospotted mites have two dark spots on the body, while McDaniel mites have four. Immatures are similar in appearance, only smaller. Eggs are round and translucent to opaque

Yellow spider mite: Adult females are pale yellow to white with two or three dark, rectangular markings on each side of the abdomen. Immatures are similar in appearance to the twospotted spider mite, but have more of a yellowish color. Eggs are clear and spherical.

Spider mites damage leaves by puncturing cells and sucking out the contents resulting in foliar injury varying from leaf yellowing and stippling to bronzing and blackening. High populations of spider mites can cause significant defoliation.

Biology and life history Twospotted, McDaniel and yellow spider mites overwinter as fertilized females under bark or in soil debris. European red mite and brown mites overwinter as eggs in crevices of twig bark and young limbs. They move to young foliage when buds break in spring and produce many generations during spring to autumn. Females can lay up to 10 eggs per day and more than 200 during their lifetime. Egg-to-adult development can occur in seven to ten days during summer. They thrive under hot, dry conditions. Large colonies of mites produce webbing. Dispersal occurs mainly through wind transport via ballooning on their webbing.

Pest monitoring Economic damage can occur at levels below 1 mite per leaf in sensitive varieties such as Anjou and Bosc. When spider mite populations are moderate (< three mites per leaf) the presence of predatory mites may allow for treatment to be delayed, but the spider mite population must then be reevaluated frequently to ensure that damaging levels of spider mites do not persist.

Management—biological control

Spider mite populations are held down by cool, wet conditions early in the season. Natural enemies, particularly lady beetles (*Stethorus* spp.), minute pirate bugs (*Orius* spp.), and predator mites such as *Typhlodromus* spp. or *Neoseiulus fallacis* (syn. *Amblyseius fallacis*) can provide some natural control. However, due to the sensitivity of many pear varieties to spider mite feeding, the effect of natural enemies can be too slow or insufficient to prevent significant damage to foliage.

Management—cultural control

Spider mite infestations are favored by dry, dusty conditions, so avoid creating these problems and stressing the plants. The use of cover crops also reduces dust and mite problems. Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or a grass groundcover may reduce mite numbers. Mites may be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control: HOME USE

Dormant-season spray

- lime sulfur—Some formulations are OMRI-listed for organic use.
- superior-type oil—Effective only against red mite. Apply at green to tight cluster stage. Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- sulfur—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Prebloom

- horticultural mineral oil at 1 to 2 gal/100 gal water or 4 to 8 gal/A. REI 12 hr. Some formulations are OMRI-listed for organic use.

Growing-season sprays:

- abamectin (Agri-Mek SC) at 2.25 to 4.25 fl oz/A. REI 12 hr. PHI 28 days. Use an adjuvant; see label. Do not exceed two applications per season. Effectiveness may be limited with late season applications.
- acequinocyl (Kanemite 15SC) at 31 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications per season.
- bifenazate (Acramite 50WS) at 0.75 to 1 lb/A. REI 12 hr. PHI 7 days. Minimum 50 gal/A ground application. Do not exceed one application

per season.

- clofentezine (Apollo SC) at 4 to 8 oz/A. REI 12 hr. PHI 21 days. Do not exceed one application of Apollo or Savey/Onager per season. Will not control adults. Combine with adulticide if adults are present. This product is not currently registered for use in Idaho.
- cyflumetofen (Nealta) at 13.7 fl oz/A. REI 12 hr. PHI 7 days. Do not exceed two applications per season.
- etoxazole (Zeal) at 2 to 3 oz/A. REI 12 hr. PHI 14 days. Use higher rates to control two-spotted or McDaniel mites and lower rates to control European red mite. Do not exceed one application per season.
- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb/A. REI 48 hr. PHI 14 days. Do not exceed two applications between petal fall and harvest. Not effective in some areas of Oregon because of resistance development.
- fenpyroximate (FujiMite SC) at 32 oz/A. REI 12 hr. PHI 14 days. Do not exceed one application per season.
- hexythiazox (Savey 50DF) at 4 to 6 oz/A. REI 12 hr. PHI 28 days. Do not exceed one application of Apollo or Savey/Onager per season. Will not control adults. Combine with adulticide if adults are present.
- hexythiazox (Onager Optek) at 16 to 24 oz/A. REI 12 hr. PHI 28 days. Do not exceed one application of Apollo or Savey/Onager per season. Will not control adults. Combine with adulticide if adults are present.
- oxamyl (Vydate L) at 3 to 4 quarts/A. REI 48 hr. PHI 14 days. Most effective against two-spotted and McDaniel spider mites. Vydate is very toxic to predatory mites. Do not exceed one application per season. Do not apply within 30 days after full bloom as fruit thinning may occur.
- pyridaben (Nexter SC) at 11 to 17 oz/A. REI 12 hr. PHI 7 days. Do not exceed one application per season.
- spirodiclofen (Envidor 2SC) at 18 oz/A. REI 12 hr. PHI 7 days. Do not exceed one application per season.

Resistance management Spider mites can develop resistance rapidly to chemical controls. Alternate chemistries and modes of action.

Pear—Stink bug

Consperse stink bug (*Euschistus conspersus*) and other stink bug species

Also see:

Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

Pest description and crop damage These insects have piercing, sucking mouthparts and a triangle between the head and the wings. Feeding on fruit causes depressions and corky areas. Stink bugs are up to 0.5 inch in length and fairly broad with a shield-shaped appearance, the color can vary from green to brown. The most damaging stink bug in western orchards is the consperse stink bug. The adult is pale brown, yellow underneath with red antennae. Brown marmorated stink bug (BMSB) is characterized by white bands on the coal-colored antennae and legs; a distinct brown "marbled" color on the back that consists of flecks of different brown colors; red eyes; and an underside that may be cream, pink, red, yellow or green.

Biology and life history These insects overwinter as adults and may migrate into orchards around bloom. Stink bugs have a wide host range and will feed on many broadleaf weeds. As broadleaf weeds around orchards dry up during the summer, stink bugs may migrate into the orchard and feed on the fruit. BMSB adults overwinter in human structures including homes, shops and outbuildings. Rock outcrops, leaf litter, and dead standing timber may also be used as overwintering sites. BMSB move out from overwintering sites into orchards in the spring where they may begin to reproduce. They may also migrate in from forest or riparian borders, or other crops throughout the growing season.

Pest monitoring Monitoring by limb tapping can aid in detection but damage to fruit is often the first indication of their presence in the orchard.

Management—cultural control

Establishment and maintenance of a weed free orchard groundcover will deter stink bugs. Do not mow cover crops or weeds when stink bugs are present since mowing may cause bugs to disperse to the fruit trees. A sod groundcover that is mowed regularly will minimize stink bug activity within the orchard.

Management—chemical control: HOME USE

- acetamiprid—Toxic to bees.
- azadirachtin (neem extract)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidicloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin clay—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season sprays:

- bifenthrin (Brigade 2EC) at 2.6 to 12.8 fl oz/A. REI 12 hr. PHI 14 days. Do not exceed 32 fl oz/A per season. Use of pyrethroid insecticides during the growing season can disrupt naturally occurring biological control and may result in increased populations of some pests.
- clothianidin (Belay) at 4 to 6 fl oz/A. REI 12 hr. PHI 7 days. Do not exceed 12 fl oz/A per season. Repeated use may induce spider mite buildup.

Pear—Tent caterpillar

Forest caterpillar (*Malacosoma disstria*)
Western tent caterpillar (*Malacosoma californica*)

Pest description and crop damage The western tent caterpillar and the forest caterpillar are the main tent caterpillar pests in the PNW. These insects attack a wide variety of plants, including alder, ash, birch, cottonwood, and willow, as well as fruit trees and roses. The adult moths are stout-bodied, light to darker brown, and are active in early to midsummer. They are attracted to lights at night.

Larvae of the forest tent caterpillar are about two inches in length, blue, with black spattered markings as well as white, footprint-shape marks. Larvae of the western tent caterpillar are hairy, dull yellow-brown, with rows of blue and orange spots on the body. Eggs of these moths are laid on twigs or buildings in masses. These masses are brown to gray, about 0.7 inch in length, and look like a brown foam case.

The larvae of both species feed in large groups on foliage of host plants and can cause significant damage by defoliation. Larvae of western tent caterpillars build large silken tents over leaves on which they feed. Larvae of forest tent caterpillars build mats of webbing rather than tents. Larvae can totally defoliate small trees, which may not kill them but reduces growth and makes the trees more susceptible to diseases or harsh weather. Healthy trees usually will grow new leaves by midsummer. Tent caterpillars rarely cause enough damage in commercial pear orchards to warrant treatment.

Biology and life history The moths overwinter as egg masses on twigs or buildings. The eggs hatch in spring as buds break in April or May. The young larvae feed in groups for five to six weeks, growing larger and molting four times. As they mature, they split into smaller groups and move to new feeding sites in the tree. The larvae pupate starting in mid-June, and the adults emerge seven to ten days later. The adults mate, and lay overwintering eggs. There is one generation per year.

Pest monitoring Look for egg masses on twigs or other overwintering sites, and remove them. Masses of young larvae are identified easily in early spring.

Management—biological control

Infestations of tent caterpillars occur cyclically as populations of the caterpillars and their predators rise and fall. Tent caterpillars have many natural enemies. Some birds eat the caterpillars, and small mammals consume the pupae. The larvae of a tachinid fly parasitizes the caterpillars.

Management—cultural control

Home orchardists: Remove egg masses from twigs or other sites. Cut out infested twigs and dip in a bucket of soapy water.

Management—chemical control: HOME USE

Dormant-season spray

- superior-type oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Products containing neem extract may be phytoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

- Chemical control for tent caterpillar is generally not required in commercial pear orchards.

Pear—Thrips

Includes
Pear thrips (*Taeniothrips inconsequens*)
Western flower thrips (*Frankliniella occidentalis*)

Pest description and crop damage Adult western flower thrips are very small (about 0.04 inch in length at maturity), slender insects with fringed wings. They are generally white when young, but brown or black when mature. Larvae are very tiny and difficult to distinguish without magnification. Pear thrips are also very small (0.06 inch at maturity). Adults of these insects are dark and perceived as mere black specks when observed on foliage. Adult pear thrips have two pairs of wings, but are weak fliers. Consequently, dispersal by adults from one infested area to another may be attributed to wind currents. The larvae have red eyes and are pale cream to translucent green which makes them difficult to observe on host foliage. Larvae sometimes congregate in groups on the foliage which makes them more conspicuous. Western flower thrips is usually not a problem in pear, however they will enter blossoms at the full pink stage to feed on pollen, nectar, and flower parts; eggs are laid in the flower parts causing oviposition scars. Feeding by pear thrips causes blasting of buds and ragging of foliage. This pest has recently become a localized problem in the Mid-Columbia fruit-growing area, especially in orchards that border habitat with native hosts such as maple and other deciduous trees.

Biology and life history Western flower thrips overwinter as adults in ground duff. Thrips usually emerge early, about popcorn stage. In the spring they seek out flowers where they feed on pollen and nectar and lay eggs into floral parts. The larvae feed on flowers, buds and leaves. When mature, the larvae drop to the ground and pupate. The adults that emerge may lay eggs on developing fruit. Under favorable conditions, a complete life cycle may be completed in two weeks. There are several overlapping generations per year. Seasonal migration occurs at various times of the year due to destruction or drying up of host plants, and adjacent crops may be invaded by these insects. Western flower thrips eat pollen and nectar from a wide range of plants (at least 244 species from 62 families).

Pear thrips are a native of Europe and have been a pest since the early 1900s on not only tree fruit but an array of forest trees. This pest spends most of the winter as an adult female in the soil. Adults emerge in early spring and disperse to a suitable host and crawl beneath a swollen bud scale to feed on immature tissue, which they can extensively damage. Eggs are laid soon after a suitable host is located. Following egg hatch, the larvae continue to feed while the adult thrips die off. The larvae drop to the soil in late spring and prepare to overwinter.

Pest monitoring Use a beating tray during pink stage to monitor and detect immigrating pear thrips along border rows of orchard.

Management—cultural control

Western flower thrips may be reduced by removing as many broadleaf flowering plants as possible from the vicinity of the trees, as this provides an alternate host. Grass groundcovers around the trees provide competition for clovers and winter annuals that are alternate hosts.

Management—chemical control: HOME USE

- Acetamiprid—Toxic to bees.
- azadirachtin (neem oil)—Products containing neem extract may be phytotoxic to some pear cultivars. Some formulations are OMRI-listed for organic use.
- bifenthrin—Highly toxic to bees.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- imidacloprid—Highly toxic to bees.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- malathion—Highly toxic to bees.
- permethrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against thrips. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients) —Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season sprays:

- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 7 days. Control of thrips may be improved by addition of an adjuvant to spray mix. Do not make more than three applications of Group 5 insecticides (spinosad and spinetoram) for thrips in a season.
- spinosad (Entrust SC) at 6 to 10 fl oz/A. REI 4 hr. PHI 7 days. Do not exceed 29 fl oz/A per year. OMRI-listed for organic use. Do not make more than three applications of Group 5 insecticides (spinosad and spinetoram) for thrips in a season.

Pear—Western boxelder bug

Boisea rubrolineata

Also see:
EM9418 Western Boxelder Bug Feeding Damage in Pear

Pest description and crop damage Insects with piercing, sucking mouthparts. Feeding on fruit causes depressions. Boxelder bug adults are oval shaped, 0.5 inch in length, black with red lines. This insect is a minor pest but damage can occur in orchards located near riparian areas or where maple and boxelder trees are present.

Biology and life history These sucking bugs overwinter as adults and may migrate into orchards early in the season. Boxelder bugs are often associated with wooded riparian areas; maple and boxelder trees are favored hosts.

Pest monitoring Monitoring by limb tapping can aid in detection but fruit inspection is needed to determine if damage is occurring in the orchard.

Management—chemical control

Insecticides used for other true bug pear pests (e.g., lygus bugs and stink bugs) may be effective. Cultural controls for orchardist include removal of boxelder trees boarding orchards.

Pear—Western tentiform leafminer

Phyllonorycter elmaella

Pest description and crop damage Adult moths are about 0.12 inch in length. The wings are held roof-like over the body and are golden bronze with white bands. Eggs are flat, translucent, and laid on the undersides of leaves. The larvae vary in appearance depending on their age, as they progress through five instars. Young larvae are legless and cream-colored. Older instars have legs and are cylindrical in shape, cream-colored and about 0.12 inch in length. Mature larvae are yellow and about 0.18 inch in length. The larvae feed within the leaf tissue creating discolored areas on the leaf. If feeding is sufficiently extensive, fruit quality and yield are reduced. This pest is primarily a problem in apples and, secondarily, in cherries and rarely causes significant damage in pears.

Biology and life history This insect overwinters as pupae in leaf litter. The adults emerge early in the season and lay eggs on the undersides of leaves around the pink stage of flower bud development. Eggs are flat and translucent. The first three larval instar stages feed on spongy soft tissue inside the leaves, creating blotches visible only on the undersurface of the leaves. Later instars develop by early to mid-May. These feed on the upper surface of the leaf beneath the epidermis, spinning silken webs to tie the mine together, giving it the characteristic “tentiform” appearance. Larvae then pupate inside the leaf. There are three to four overlapping generations per year.

Pest monitoring Eggs and mines can be observed on the leaves but no thresholds have been established for this pest in pears.

Management—biological control

Parasitic wasps, especially *Pnigalio flavipes*, can provide substantial natural control of this pest. Leafminer problems may be induced by loss of biological control due to broad spectrum insecticides.

Management—chemical control: COMMERCIAL USE

Chemical control for western tentiform leafminer is generally not required in commercial pear orchards.

Management—chemical control: HOME USE

Chemical control for western tentiform leafminer is generally not required in home pear orchards.

Plum and Prune Pests

Heather Stoven and Michael R. Bush

Latest revision—March 2024

INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL AND HOME USE

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.

The following management information provides a suggested amount of each formulation per acre when applied to mature trees. The size of trees, amount of foliage, type of equipment used, and other factors are important in determining the amount of spray to use per acre. Read carefully the entire label of each material before application.

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

Mite identification: See Field Characteristics of Fruit-Tree-Attacking Spider Mites in the Pacific Northwest.

Note: Products are listed in alphabetical order and *not* in order of preference or superiority of pest control. Active ingredients marketed under other product names may provide equivalent control, but read product label first to check legal status before making any application.

Plum and prune—Aphid

Hop aphid (*Phorodon humuli*)
Leaf curl plum aphid (*Brachycaudus helichrysi*)
Thistle aphid (*Brachycaudus cardui*)

Pest description and crop damage Several aphid species attack plums and prunes, including the leafcurl plum aphid, hop aphid, and thistle aphid. The leafcurl plum aphid varies considerably in color from shiny green to brownish-green or brownish yellow. Hop aphid ranges from green as wingless adults to near black as winged adults. The thistle aphid is relatively large (approx. 0.1 inch long), shiny green with dark patches on its back. Initially, aphids feed on the shoot tips, which on young trees can cause stunting and malformation of the shoot tips. On older trees, fruit set is reduced in subsequent years if aphid populations are high. Aphids also produce a sticky, sweet honeydew that promotes sooty mold problems on fruit.

Biology and life history Aphids have complicated lifecycles that include multiple host plants, reproductive strategies, and adult forms. The hop aphid overwinters as eggs in crevices and twigs on *Prunus* trees, the primary hosts. Plum/prune trees are the preferred overwintering hosts, but peaches and cherries are also used. The eggs hatch in late March, and several generations of wingless females feed and reproduce on the plum/prune trees before the winged females migrate to the secondary host—hops—in May. Several generations of wingless females are on the hops as late as August and September. Then winged adults fly back to the *Prunus* hosts and, after mating, lay the overwintering eggs around buds, bud scales, or cracks in the bark of twigs and shoots. The life cycles of the other two aphids are roughly similar. Many secondary summer hosts of the leafcurl plum aphid and the thistle aphid are plants in the family Asteraceae, which include chrysanthemum, mayweed, and groundsel.

Pest monitoring Begin observing shoots prior to budbreak, as management is most effective early while aphid abundance is still low and before the emerging leaves begin to curl about and protect aphid colonies.

Management—biological control

Aphids have many natural enemies, which include lady beetles, syrphid fly larvae, and green lacewings. Avoid broad-spectrum insecticide applications that disrupt the life cycles of these natural enemies.

Management—cultural control

Home orchardists: Wash aphids from plants with a strong stream of water or by hand wiping. Aphid populations tend to be higher in plants overly fertilized with nitrogen. Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth.

Management—chemical control: HOME USE

Dormant-season spray

Apply only during dormant or delayed-dormant period. Apply with enough water to cover the entire tree thoroughly.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

Apply according to label specifications, when overwintering eggs hatch during prebloom or petal fall. Summer applications should be before leaves curl.

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against aphids. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Apply when aphid eggs hatch during pre-bloom or petal fall. In summer, apply before leaves curl for best control. Fall sprays can provide excellent aphid control for the next growing season.

Dormant and delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—Use oil sprays during dormant or delayed-dormant period. REI varies, check product label. Some formulations are OMRI-listed for organic use.

Prebloom spray

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb product or 6 gal oil per acre. If applied in late April or May, mix diazinon with 1 gal light to medium summer horticultural oil per 100 gal water. Do not exceed one in-season foliar application per growing season.

Spring and summer spray

- acetamiprid (Assail 30SG) at 2.5 to 5.3 oz/A. REI 12 hr. PHI 7 days.
- imidacloprid (Prey 1.6F, Nuprid 1.6F) at 2 fl oz/100 gal water (4 to 8 fl oz/A). REI 12 hr. PHI 7 days. **Warning:** Toxic to bees. Do not use until pollination is complete and bees have left the orchard.
- spirotetramat (Movento, Ultor)—Product formulations vary, check label for rates. REI 24 hr. PHI 7 days.
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 4 to 6 oz/A. Do not apply exceed 14 oz/A or 0.172 lb/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

Postharvest spray

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb product or 6 gal oil per acre. If applied in late April or May, mix diazinon with 1 gal of light to medium summer horticultural oil per 100 gal water. REI 4 days. PHI 21 days. Do not exceed one in-season foliar application per growing season.

Plum and prune—Apple-and-thorn skeletonizer

Choreutis pariana

Pest description and crop damage Adult moth is reddish brown with a wingspread less than 0.5 inch, and irregular light and dark bands on the wings. Mature larvae are 0.5 inch long, yellowish to greenish, with black spots and a yellow-brown head. The larvae roll and secure leaf edges together then selectively feed on leaf tissues between veins creating a "skeletonized" leaf appearance. They also feed on apple, crabapple, cherry, and hawthorn. Pupae are yellow to brown and found within a white silken cocoon.

Biology and life history Adult moths overwinter in crevices in the tree. They lay eggs in small bunches on the undersides of leaves. The larvae emerge and feed on the undersides of the leaves, then move to the top surface and feed there, often tying the sides together creating a "rolled" effect. There is often more than one caterpillar in the roll and the leaf ends up skeletonized. After 3 to 4 weeks, they pupate in the rolled leaf. Adults emerge after about two weeks to start a new generation. There are at least two generations per year.

Pest monitoring Watch for signs of skeletonizing, which from a distance looks like the leaf tips have been burned.

Management—biological control

There are many natural enemies of this pest. Avoid broad-spectrum sprays that would disrupt this system.

Management—cultural control

Home orchardists: Larvae and pupae are removed easily from rolled leaves. Remove heavily infested twigs.

Management—chemical control: HOME USE

There are no products registered for control of this pest in home garden plums and prunes.

Management—chemical control: COMMERCIAL USE

Typically, not a pest problem in commercial orchards.

Plum and prune—Cutworm (climbing)

Includes
Spotted cutworm (*Xestia c-nigrum*)
Variegated cutworm (*Peridroma saucia*)

Pest description and crop damage Several species of cutworm attack tree fruits. The adults are large moths that range in color from gray to brown and have characteristic spots on their wings. These moths are attracted to lights. Mature larvae are dirty white, reddish, gray, or black caterpillars 1.5 to 2 inches long. The larvae of these moths feed on buds and leaves, chewing holes in buds and ragged holes out of leaves. They also feed on the growing tips, particularly on small trees or in high density plantings. On larger trees, most of the feeding is on the lower branches, and may be concentrated to a few stems or limbs, while other limbs are undamaged.

Biology and life history Weeds are the preferred source of food for these larvae, and eggs typically are laid on weeds in the orchard ground cover. Depending on species, they may overwinter as pupae or larvae in the soil. The larvae spend the day hidden in the soil. At night, the larvae climb up the tree to feed on buds or leaves, often following the same path as previous nights.

Management—cultural control

Control weeds, grasses, and debris in the orchard that provide cover. Encourage natural enemies of cutworms like birds and spiders. If practical, seek out and handpick cutworm larvae at night using a flashlight to find them. Scratch the soil at the base of plants to find larvae in the daytime. Caterpillars are trapped by tying plastic wrap tightly around branches and trunk, then applying a sticky adhesive to the plastic wrap. Remove these wraps in the fall.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

No products are registered for control of this pest.

Plum and prune—Earwig

Primarily European earwig (*Forficula auricularia*)

Pest description and crop damage Adult earwigs are elongate, flattened, reddish-brown insects about 0.60 inch long with forceps-like pincers on the end of their abdomens. They have chewing mouthparts and are fully winged. Young earwigs (nymphs) are similar in appearance but are white to olive green and lack wings. Earwigs are harmless to humans or animals, though they may give a slight pinch with their pincers. They can emit a foul-smelling liquid if alarmed. Earwigs feed primarily on decaying organic matter and are quite beneficial in that they consume smaller insects. However, they also may chew small holes in the tree leaves and overripe fruit of stone fruits.

Biology and life history Earwigs overwinter just below the soil surface as both eggs and adults. In spring, females lay 20 to 50 smooth white to cream-colored eggs in the soil then nurture the immature nymphs. The young grow through four to five instars until they reach adults by late summer. In fall, females may lay more eggs. Earwigs are active at night. During the day, they hide in moist, shady places such as compost piles and beneath stones, boards, or debris. They rarely fly, but are carried, inadvertently, with lumber, cars, luggage, or other materials. At night, earwigs are attracted to lights.

Pest monitoring If you see damage to young leaves, you can confirm the presence of earwigs by placing a sheet of corrugated cardboard, hollow bamboo canes, sections of old garden hose, or similar material on the ground that provide shelter for earwigs. Check the materials each morning for presence of earwigs. To dispose of the trapped insects, empty shelter traps each morning into a pail of water topped with detergent. Infestations spread slowly, as earwigs rarely fly.

Management—cultural control

Home Orchardists: Cultivation of the soil in early spring in areas where earwigs are present will disturb nests, physically damage earwigs, and expose eggs to predators. Do not allow debris and decaying organic matter to accumulate in the garden. Before the spring emergence of nymphs, wrap the trunk tightly with plastic wrap to ensure that earwigs do not crawl beneath the wrap. Earwigs are trapped with a sticky adhesive, or a similar material applied at the trunk of the tree to prevent their crawling up into the canopy of the tree. Apply the sticky adhesive to the plastic wrap, not the tree as that can soften bark. Remove these bands before winter. Earwigs may be trapped following the monitoring techniques described above. Earwigs are attracted strongly to fish oil and to some extent vegetable oil. Trap earwigs by filling a shallow container with the fish oil and burying it in soil up to its rim.

Management—biological control

Tachinid fly larvae are parasites of earwigs.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Apply around trunk at ground level only.
- gamma-cyhalothrin
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- plant-derived essential oils—Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- spinosad—Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Dormant and delayed-dormant spray

- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A product. REI 12 hr. Spray around bases of trees and trunk. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.

Plum and prune—Eyespotted bud moth

Spilonota ocellana

Pest description and crop damage Adults are greyish moths about 0.5 inch long with a thick white band on each forewing. Mature larvae are chocolate-brown with black heads, and less than 0.5 inch in length. The eyespotted bud moth is principally a pest in Oregon.

Biology and life history Larvae spend the winter in a cocoon on the bark in the crotches of small-diameter limbs. They become active around budbreak and feed on leaves and buds, webbing together leaves and flower petals, then feeding within these tissues. Mature larvae pupate within the webbed tissues and adult moths emerge in early to mid-summer. Eggs are laid on the lower surface of leaves. The larvae emerge and feed on the lower leaf surface until early August, at which time they construct their overwintering cocoons (hibernacula).

Pest monitoring In the spring, look for larvae in nests of webbed-together leaves and flower petals.

Management—chemical control: HOME USE

- carbaryl—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Growing-season spray

- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A. REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.

Plum and prune—Grape mealybug

Pseudococcus maritimus

Pest description and crop damage The newly-hatched nymphs (or crawlers) are purplish and covered with a powdery wax coating. As the nymphs get older, the coating gets thicker, a fringe of wax filaments develops, and the nymphs become more sedentary. The adult female is wingless and looks like a nymph. The adult female can be up to 3/16 inch long and has a well-developed ring of waxy filaments around the sides of her body. Mealybug damage results from the honeydew this insect excretes. Honeydew is cast off in small droplets, rains down through the canopy and collects on plant surfaces beneath which can promote the growth of sooty mold.

Biology and life history Grape mealybug overwinters as crawlers in egg sacs beneath bark scales and in cracks. Crawlers start emerging from egg sacs at the beginning of bud swell and begin feeding at the base of buds. As buds open, crawlers go directly to new shoots and leaves. Once settled, the crawlers start feeding and become progressively harder to kill as they develop the wax coating. First generation nymphs mature during late June and July in the Pacific Northwest. For each generation, winged adult males emerge first. Later, wingless female mealybugs emerge and release a pheromone to attract males. Then the mated females migrate to sheltered areas, lay eggs, and die in the egg sac. A partial second generation matures in late August and September. Nymphs of this generation sometimes settle in or around the fruit calyx.

Management—biological control

Few reports are available on the effectiveness of natural enemies in keeping mealybug populations at levels below economic damage in the PNW. Parasitic wasps, predatory bugs, predatory beetles, lacewings, and spiders can take a considerable toll on mealybugs when few broad-spectrum chemicals are used. A lady beetle and its larvae, known as the “mealybug destroyers” (*Cryptolaemus montrouzieri*), are considered an effective predator of mealybugs worldwide. They are available from some commercial insectaries.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Plum only. Some formulations are OMRI-listed for organic use.

- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Prebloom spray

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A) plus 2 to 3 gal dormant oil or 1 to 1.5 gal superior type oil per 100 gal water. REI 4 days. PHI 21 days. Do not exceed one in-season application per growing season.

Spring and summer spray

- acetamiprid (Assail 30SG) at 8 oz/A. REI 12 hr. PHI 7 days.
- imidacloprid (Prey 1.6F, Nuprid 1.6F) at 4 to 8 fl oz/A. REI 12 hr. PHI 7 days. Warning: Toxic to bees. Do not use until pollination is complete and bees have left the orchard.
- spirotetramat (Movento, Ultor)—Product formulations vary, check label for rates. REI 24 hr. PHI 7 days.

Plum and prune—Leafhopper

Includes
Rose leafhopper (*Edwardsiana rosae*)
White apple leafhopper (*Zonocyba* (*Typhlocyba*) *pomaria*)

Pest description and crop damage The common leafhopper pest in the PNW is the white apple leafhopper, although a very similar-appearing insect, the rose leafhopper, is also present. Other species are found throughout the Pacific Northwest. Adults are about 0.125 inch long, white to yellow in color, with wings held tent-like over the body. Nymphs are light green and may move rapidly if disturbed. Adults and nymphs suck juices from leaves, causing stippling and mottling on leaves. Damage usually is most noticeable on poorly cared-for trees. In general, this pest is a minor problem, and even high populations rarely cause yield loss. The flying adults may become a nuisance pest during fruit harvest.

Biology and life history The insect overwinters as eggs just beneath the bark on 1 to 5 year-old twigs in the trees. Presence of the eggs is indicated by characteristic oblong, crescent-shape swellings in the bark. Eggs hatch at about the tight cluster stage (late March to mid-April), and nymphs feed for several weeks. Adults are flying by late May until frost when they are killed by the cold. Overwintering eggs are laid in September. There are two generations per year.

Pest monitoring As a minor pest, monitoring is not necessary, although the presence of the adults can be confirmed by early morning limb taps.

Management—biological control

Parasitic wasps provide some control over leafhopper populations.

Management—chemical control: HOME USE

- azadirachtin (neem extract)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafhoppers. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer spray

- carbaryl (Carbaryl 4L) at 2 to 3 quarts/A. REI 12 hr. PHI 3 days. Extremely toxic to aquatic invertebrates; avoid spray drift and runoff to surface waters.
- esfenvalerate (Asana XL) at 5 to 12 fl oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A. Do not exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

Plum and prune—Leafroller

European (filbert) leafroller (*Archips rosana*)
Fruittree leafroller (*Archips argyrospila*)
Obliquebanded leafroller (*Choristoneura rosaceana*)
Pandemis leafroller (*Pandemis pyrusana*)

Pest description and crop damage There are several species of leafroller pests of tree fruits. The larvae of these moth species can use native plants as well as fruit trees as hosts. They all cause similar damage to the trees but differ in their appearance and in their life cycle. These principal leafroller

pests of fruit trees are divided into single-generation moths, such as the fruit-tree leafroller and the European leafroller, and two-generation moths, such as the obliquebanded leafroller and pandemis leafroller. Adults of these species measure between 0. 5 to 1 inch in length and range from fawn-color to dark brown with distinctive bands or mottling on the wings. The larvae of these species are all green caterpillars with a light brown to black head, depending on the species. Larvae roll and tie leaves together for shelter and feeding. Mature larvae may be from ¾-inch to a full inch long. They thrash about violently when disturbed and may drop from the leaf suspended by a silken thread. Feeding on growing points on young plants can promote undesirable branching. Larvae also feed on the surface of the fruit, causing deep, russeted scars.

Biology and life history The single-generation leafrollers overwinter as egg masses on twigs and branches. Eggs hatch in spring, as buds are opening, and continue until petal fall. The larvae feed for 4 to 6 weeks, then pupate in the rolled leaves and finally emerge as moths in early summer. The overwintering eggs are laid in July. Two-generation leafrollers overwinter as immature larvae under the bark on scaffold branches of a variety of host plants. Larvae may feed during warm periods in winter but become most active in spring with onset of new growth. They feed for several weeks, and then pupate in rolled leaves. Adult moths emerge in late April to May. These moths mate and lay eggs for the next generation. The next generation hatches in early summer and does the most damage.

Pest monitoring In early spring, observe tree growth for rolled leaves and feeding damage on new growth.

Management—biological control

Very low temperatures in winter and late spring frosts significantly reduce overwintering populations of larvae. Spiders and parasitic wasps, as well as predators like the brown lacewing, greatly reduce leafroller populations throughout the year.

Management—cultural control

Home orchardists: Handpick rolled leaves containing larvae or pupae. Removal of overwintering sites, such as rolled leaves on the ground can reduce next year's population.

Management—chemical control: HOME USE

Dormant spray

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—May require several applications. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against leafrollers. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant and delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—Use oil at this concentration only in the dormant period. REI varies; check product label. Some formulations are OMRI-listed for organic use.

Prepink spray

- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.
- thiamethoxam/chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A. Do not apply exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

Bloom spray

- *Bacillus thuringiensis* var. *kurstaki*—Check labels for rates. REI 4 hr. Bt products work best if temperatures exceed 50°F over 3 consecutive days. Some formulations are OMRI-listed for organic use.

Spring and summer spray

- *Bacillus thuringiensis* var. *kurstaki*—Check labels for rates. REI 4 hr. PHI 0 days. Bt products work best if temperatures exceed 50°F over 3 consecutive days. Apply sprays 14 to 21 days apart. Some formulations are OMRI-listed for organic use.
- flubendiamide+buprofezin (Tourismo) at 10 to 14 fl oz/A. REI 12 hr. PHI 14 days.
- methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/A. REI 4 hr. PHI 7 days. For each generation, apply when egg hatch begins and before larvae enter fruit. Reapply in 10 to 14 days to ensure complete coverage of rapidly expanding fruits or foliage, or under conditions of high infestation or sustained moth flight.

- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.
- thiamethoxam+chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A. Do not apply exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

Resistance management Leafrollers can develop resistance rapidly to chemical controls.

Plum and prune—Lesser appleworm

Aspila (*Grapholita*) *prunivora*

Pest description and crop damage This tortricid pest is closely related to and has characteristics similar to Oriental fruit moth. The larvae feed inside the fruit, often entering through the calyx end.

Biology and life history The lesser appleworm prefers host plants in the rose family including crabapples, hawthorn, wild rose and others. It overwinters as mature larvae (measuring less than 0.4 inch long) at the base of host plants or under bark scales. The adults begin to emerge in April, and females lay eggs on leaves or the fruit surface. The larvae feed on the fruit for about three weeks, and then pupate at the base of the tree or under bark scales. Second-generation adults appear in late spring. These adults also lay eggs on the fruit. Late in the season, mature larvae spin cocoons to overwinter.

Management—chemical control: HOME USE

- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Lesser appleworm is not currently a problem in commercial orchards in the PNW.

Plum and prune—Lygus bug and stink bug

Brown marmorated stink bug (*Halyomorpha halys*)
Consperse stink bug (*Euschistus conspersus*)
Western boxelder bug (*Boisea rubrolineata*)
Western tarnished plant bug (*Lygus hesperus*) and other *Lygus* spp.

Pest description and crop damage Adult stink bugs are all shield-shaped, with a triangle-shaped section in the middle of their backs. They are generally up to about 0.5 to 0.6 inch long. The name "stink bug" refers to the strong odor that the insects can emit if alarmed or harmed. The consperse stink bug is pale brown, yellow on the underside and has red antennae. Brown marmorated stink bugs (BMSB) are brown, resembling tree bark, and have white bands on their antennae. The western boxelder bug is about 0.5 inch long and one-third as wide. Adults are mostly black and have three red lines on the pronotum of the thorax (one down the center) and several fine red lines on each wing. The wings lie flat on the bug's back when it is at rest. The abdomen is red. The young nymphs are bright red and when about half-grown become marked with black and begin to develop black wing pads. Adult lygus bugs are oval, about 0.2 inch long with a light yellow 'V' on the back. The bugs feed on developing leaves, flowers, and fruit, which kills the tissue around the feeding site. They pierce and damage fruit with their mouthparts which leads to fruit "catfacing" later in the season.

Biology and life history Adults overwinter in groundcover. They feed early in the season on weeds and may move later into other host plants. Stink bug damage is worse in dry summers when alternative hosts dry up sooner in the season.

Management—cultural control

Eliminate weeds that serve as protection and food for bugs early in the season.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees. Stink bug only.
- pyrethrins (often as a mix with other ingredients)—Highly toxic to bees. Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Prebloom spray

- esfenvalerate (Asana XL) at 5 to 14 fl oz/A. REI 12 hr. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.

Spring and summer spray

- esfenvalerate (Asana XL) at 5 to 14 fl oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- thiamethoxam+chlorantraniliprole (Voliam Flexi) at 6 to 7 oz/A. Do not apply exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

See also, in this Handbook:

Brown Marmorated Stink Bug: An Emerging Threat to Pacific Northwest Agriculture

For more information

Brown Marmorated Stink Bug (https://catalog.extension.oregonstate.edu/em9054)

Brown Marmorated Stink Bug (https://treefruit.wsu.edu/crop-protection/opm/brown-marmorated-stink-bug)

Plum and prune—Pacific flatheaded borer

Chrysobothris mali

Pest description and crop damage The Pacific flatheaded borer is a pest of many different trees and shrubs, including most fruit trees. Adults are reddish bronze beetles with copper-colored spots on wing covers, and about 0.25 to 0.5 inch long. Larvae are whitish to pale yellow and about 0.5 inch long when fully developed. Just behind the head of the larvae is a broad, flat enlargement giving a "flat-headed" appearance. Larvae feed beneath the bark and may girdle the trunks and branches of trees. Young and recently planted trees are most susceptible especially when infested host trees are nearby. Trees that are stressed because of drought or other causes are also vulnerable.

Biology and life history This insect overwinters in host plants as mature larvae. In spring, they pupate and then bore exit holes in the tree. They emerge usually from May to June. Females lay eggs from June through July in crevices in the bark, usually on the sunny side of tree trunks below the lowest branches. Stressed trees are the preferred egg-laying site. The larvae hatch, burrow into the wood, and feed on the cambial and vascular tissues until full grown. Burrows are characteristically broad and irregular.

Pest monitoring Watch for depressions in the bark or cracks through which frass (excrement) may be seen.

Management—biological control

Birds peck the larvae from under the bark with their beaks. Some wasp parasites attack the borer. Carpenter ants eat both larvae and pupae from the wood.

Management—cultural control

These beetles are attracted to weakened, sunburned, or injured parts of the trunk and lay eggs in cracks on bark exposed to the sun. Protect young, newly planted trees from sunburn by white-washing, paper trunk protectors, or shading the trunks with boards. Follow good pruning, watering, and fertilization practices. Keeping weeds, grass, and trash from the base of the trees. This makes it easier for predators to detect and prey on borers. Remove infested limbs and any nearby firewood that may contain borers.

Management—chemical control: HOME USE

- imidacloprid—Plum only. Soil drenches may have residual activity in woody plants lasting for twelve or more months. If short-term management is the goal, consider other approaches.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

No effective insecticides are registered.

Plum and prune—Peachtree borer

Synanthedon exitiosa

Pest description and crop damage The adult male is a steel-blue, clear-winged moth and a little over one-inch in length. The female is similar in appearance but has smoky-colored wings and an orange band around her abdomen. Adult flight is usually from late June through September and eggs are laid at, or on, the base of the fruit tree. Larvae burrow in the crown and roots, girdle young trees, and weaken others. A single larva can girdle a newly planted fruit tree. Larval presence can best be detected by globs of gum mixed with a granular brown frass (excrement) that appear at the base of infested fruit trees. Full-grown larvae are 1 to 1.4 inches in length with a whitish body and a brown head.

Management—cultural control

Protect the base of the fruit tree from larval entry by placing a plastic or metal cone or barrier around it before egg laying begins. The cone should be pushed one to two inches into the soil and should fit snugly around the trunk at the top to prevent the tiny larvae from getting beneath it. Alternatively, if there are only one or a few peach trees in a home orchard, it may be quicker and cheaper to control this insect by "worming." Use a pocketknife, wire, or some pointed instrument to remove dirt around the tree and dig out the larvae.

Management—chemical control

Spray applications, and more importantly pesticide residues, on the trunk of the tree can prevent newly hatched larvae from boring beneath the tree bark and entering the woody trunk where they are protected from all insecticide sprays.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- gamma-cyhalothrin—Highly toxic to bees.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrin—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer sprays

- esfenvalerate (Asana XL) at 4.8 to 14.5 fl oz/A. REI 12 hr. PHI 14 days. Extremely toxic to fish and aquatic invertebrates; avoid spray drift and runoff to surface waters.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- Isomate P at 100 to 250 dispensers/A. These dispensers release a synthetic insect pheromone that disrupts moth mating. Dispensers must be placed in the orchard before adult mating and egg-laying flight begins in late June or when the first moths are captured in pheromone traps. Careful scouting and monitoring are necessary to use this product effectively.

Plum and prune—Peach twig borer

Anarsia lineatella

Pest description and crop damage Peach twig borer is a European insect first found in California in the 1880s. It is a major pest of apricots, peaches, plums, and prunes. There are no native hosts outside the orchard. The adult is a gray moth with white and dark scales, about 0.3 to 0.5 inch long. The larva is a caterpillar, about 0.5 inch in length, with a dark brown head and distinctive, alternating light and dark bands on the body. The pupa is smooth and brown. The larva of the borer causes injury to fruit and trees. Feeding on the buds and twigs occurs early in the season, after which the larva bores into the shoots, causing a characteristic "flagging" or wilting of new growth. Later generations of larvae feed on shoots or fruit, disfiguring the fruit. Flagging of twigs indicates an infestation.

Biology and life history The borer overwinters as an immature larva in tunnels constructed in the crotches of twigs and branches. These overwintering sites can be identified by the small chimneys of frass (excrement) and wood fragments produced by the feeding of the larvae. Larvae become active at the pink bud stage and emerge to feed on buds and young leaves before boring into a shoot. These larvae eventually leave the mined shoot to pupate. Adults then emerge in mid- to late May. Eggs are laid on fruit, shoots, or undersides of leaves. Eggs are yellowish white to orange. The eggs hatch, and these larvae feed and mature on shoots and immature fruit. The next adult flight is in mid-July. Some of the larvae from this flight will overwinter, and the rest will produce a partial third flight.

Pest monitoring Check for overwintering sites on small trees. Otherwise, examine shoots in late April or early May. Wilted shoots are easy to spot, and you should open them to check for larvae.

Management—biological control

Tiny parasitic chalcid wasps are active in orchards at shuck fall that parasitize moth eggs while braconid wasps parasitize borers within plant tissues.

Management—cultural control

Home Orchardists: Cut out mined shoots below the wilted area to eliminate larvae. Overwintering larvae may be found and destroyed under thin bark in branch crotches. Look for a buildup of chewed bark and frass (excrement) when monitoring.

Management—chemical control

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—Some formulations OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- esfenvalerate—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.

- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Prebloom spray

- flubendiamide+buprofezin (Tourismo) at 10 to 14 fl oz/A. REI 12 hr.
- spinetoram (Delegate WG) at 3 to 7 oz/A. REI 4 hr.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.

Spring and summer spray

- *Bacillus thuringiensis* var. *kurstaki*—Check labels for rates. REI 4 hr. PHI 0 days. Bt products work best if temperatures exceed 50°F over 3 consecutive days.
- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). Do not apply more than 4 lbs. of product or 6 gals. of oil per acre per year. REI 4 days. PHI 21 days. Do not exceed one in-season foliar application per growing season.
- flubendiamide+buprofezin (Tourismo) at 10 to 14 fl oz/A. REI 12 hr. PHI 14 days.
- phosmet (Imidan 70W) at 2.13 to 4.25 lb/A. REI 7 days. PHI 14 days. Mechanical harvest permitted 7 days after application.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.
- thiamethoxam+chlorantraniliprole (Voliam Flexi) at 4 to 7 oz/A. Do not apply exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.

Plum and prune—Rust mite

Includes
Big-beaked plum mite (*Diptacus gigantorhynchus*)
Plum rust mite (*Aculus fockeui*)

Pest description and crop damage These adult mites are four-legged and wedge-shaped. They are variable in color, being yellow or pinkish-white or purple. The adults are minute and are barely seen with the naked eye when placed against a black background. Immature mites are similar in structure to adults, but smaller and white. The mites feed on the surface of the leaf with piercing–sucking mouthparts, sucking fluids from individual plant cells. Mature plum foliage may be curled upward or dwarfed. The lower surfaces of the leaves become brown or bronze and scurfy. Feeding on younger leaves causes development of small yellow spots on the leaves, followed by leaf "shotholing". The impact of this feeding on vigor and yield is uncertain. Nevertheless, they are rarely a significant pest and seldom cause damage to prunes west of the Cascades.

Biology and life history These mites overwinter as an adult female under bud scales. As the buds expand, they leave the buds, scatter over the expanding foliage, and feed for several days before laying eggs. A complete generation requires six to 22 days, and generations are produced continuously in summer. As foliage hardens or degrades, adult females prepare to overwinter and emerge in the following spring.

Pest monitoring Observe the leaves for signs of feeding and use a hand lens of at least 20X power to check for the mites.

Management—biological control

Phytoseiid predator mites in the family Phytosiidae can keep mites under control when broad-spectrum insecticide applications are avoided. Rust mites are a significant food source for these predator mites, so early season damage from this mite is tolerated. Hot, dry weather and the probable hardening off of leaves that this causes also reduce mite numbers.

Management—chemical control: HOME USE

Dormant-season spray

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- sulfur—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Dormant to delayed-dormant spray

- horticultural mineral oil (rates vary; check product label)—Use oil at the highest concentration only in the dormant period. REI varies; check product label. Some formulations are OMRI-listed for organic use.

Spring and summer sprays

- abamectin (Abamex) at 2.5 to 5 fl oz/100 gal (10 to 20 fl oz/A). REI 12 hr. PHI 21 days. Apply when mites first appear. Do not exceed two applications of abamectin products per season.
- elemental sulfur (rates vary; check product label)—REI 24 hr. No PHI listed. Some formulations OMRI-listed for organic use.
- pyridaben (Nexter) at 10.67 oz/A. REI 12 hr. PHI 7 days. Do not exceed two applications per season.
- spirodiclofen (Envidor 2SC) at 18 fl oz/A. REI 12 hr. PHI 7 days. Limited to one application per season.

Plum and prune—Scale

European fruit lecanium (*Parthenolecanium corni*)
San Jose scale (*Quadraspidiotus perniciosus*)

Pest description and crop damage Lecanium scales are up to 0.2 inch across, reddish brown, and rounded, resembling small helmets or bumps on branches, stems, and the underside of leaves. The immature "crawlers" are flat, oval, and pinkish brown. San Jose scale is less than 0.1 inch in size and has a tiny white knob in the center with a series of grooves or rings around it. Severe infestations can kill twigs. Large quantities of honeydew are produced, which makes leaves and fruit beneath the scale infestation shiny and sticky. Sooty mold fungus may grow on this, giving the plants a dirty, sooty appearance.

Biology and life history Lecanium scale overwinters as an immature scale on twigs and branches. They resume feeding in the spring, and eggs are laid underneath the scales in May to June. The eggs remain under the scales until hatching in early summer. The young scales, called "crawlers," migrate to the undersides of leaves to feed. Young scales can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. After four to six weeks on the leaves, the young return to the stems and twigs to feed, mate, and overwinter. There is one generation per year.

San Jose scale overwinters as immature scales and are black in color. In spring, the tiny, winged males emerge and mate with wingless females. The immature crawlers are very small, flattened, and yellow, and move around on bark and foliage before settling down to feed. Young scales can be dispersed by wind, rain, irrigation, or by the movement of people and machinery. A few days later, they secrete a waxy coating over their body that protects them from pesticides; therefore, time pesticide applications when crawler populations are present. From this point, female scales do not move. Crawlers appear during June and July and again in August to September, so there are two generations per year.

Pest monitoring Inspect twigs during the dormant season for scales. Pay attention to weak plants. The crawlers are best observed during May to July with a 10X magnifying lens. Crawlers can be monitored by wrapping a piece of black sticky tape around an infested branch with the sticky side out.

Management—biological control

Larvae of green lacewings, lady beetles, and other insects are aggressive predators of scale.

Management—cultural control

Home Orchardists: Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. Non-toxic sticky adhesive can be applied around infestations of adult scales to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer or water applications, as these favor increases in scale populations.

Management—chemical control: HOME USE

Dormant-season spray

Apply only during dormant or delayed-dormant period. Use enough water to cover all the tree thoroughly including small limbs and shoots.

- horticultural mineral oil—Some formulations are OMRI-listed for organic use.

Growing-season spray

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Plum only. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against scale. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)— Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Dormant to delayed-dormant spray

If lecanium scale is the main problem, dormant oil sprays are most effective. If San Jose scale is the main problem, use oil plus diazinon.

- diazinon (Diazinon 50W) at 3 to 4 lb/A (1 lb/100 gal minimum). REI 4 days. PHI 21 days. Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb product or 6 gal oil per acre. If applied in late April or May, mix diazinon with 1 gal of light to medium summer horticultural oil per 100 gal water. Do not exceed one dormant application of diazinon per growing season.
- horticultural mineral oil (rates vary; check product label)—Use oil at the highest concentration only in the dormant period. REI varies; check product label. Some formulations are OMRI-listed for organic use.
- pyriproxyfen (Esteem 35 WP) at 4 to 5 oz/A + horticultural mineral oil (rates vary; check product label). REI 12 hr.

Spring and summer spray

If delayed-dormant spray has not been applied, then a summer spray will effectively control scale in the crawler stage. Summer spray is directed at those crawlers that appear in late June, mid-July, and September.

- buprofezin (Centaur WDG) at 34.5 oz/A. REI 12 hr. PHI 14 days. Do not exceed two applications per season.

- diazinon (Diazinon 50W) at 1 lb/100 gal water (4 lb/A). REI 4 days. PHI 21 days. Apply as a dormant spray. When using spray oils, follow spray oil manufacturer's use directions. Do not apply more than 4 lb product or 6 gal oil per acre. If applied in late April or May, mix diazinon with 1 gal of light to- medium summer horticultural oil per 100 gal water. Do not exceed one in-season application per growing season.
- phosmet (Imidan 70W) at 2.13 to 4.25 lbs/A. REI 7 days. PHI 7 days.
- pyriproxyfen (Esteem 35WP) at 4 to 5 oz/A. REI 12 hr. PHI 14 days.
- spirotetramat (Movento, Ultor)—Product formulations vary, check label for rates. REI 24 hr. PHI 7 days. Under heavy scale infestation pressure or where difficult control conditions exist, a second application may be necessary.

Plum and prune—Shothole borer

Includes
Ambrosia beetles (*Xyleborinus* spp.)
Shothole borer (*Scolytus rugulosus*)

Pest description and crop damage Shothole borers are small beetles introduced to North America and have been found in the PNW since the early 1900s. They are pests of forest trees, ornamental shade trees, and shrubs as well as fruit trees. Apple, pear, cherry, and plum are all attacked. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees, or infested wood piles may be attacked. The adult shothole borer is a brownish black beetle about 0.1 inch long. The larvae are white, legless, and about 0.15 inch long. A similar wood-boring beetle, the ambrosia beetle, is about 0.1 inch long, dark brown or black, and covered with yellowish hairs. The larva is pinkish-white, legless, cylindrical, and 0.1 inch long when mature. Larvae and adults of both these species bore into the cambial and vascular tissues of trees, weakening them and causing wilting and dieback of individual stems and branches. Trunks and branches are completely riddled with galleries.

Biology and life history Shothole borer overwinters as a larva in burrows beneath the bark of infested trees. They pupate within the tree. Adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. Adults then tunnel into the tree, excavating galleries parallel to the wood grain. They lay eggs along the gallery. The eggs hatch, and the larvae feed by tunneling at right angles to the main burrow, causing a characteristic pattern of damage. The burrows are filled with frass (excrement) and increase in diameter as the larvae mature. After 6 to 8 weeks, the larvae pupate at the ends of the galleries then emerge as adults starting in August. There are many small, round, exit holes that give the host's branch a "shothole" effect. There are two generations per year.

Ambrosia beetles overwinter as mature larvae, pupae, or adults in galleries in the tree. When spring temperatures exceed 65°F, the females become active, fly to susceptible hosts, and bore into the tree. Eggs are laid in the gallery, and as they develop, the female carefully tends them and cultivates ambrosia fungus for them to eat. The females usually remove excrement or wood dust from the tunnels, and this, along with the uniform width of the galleries, distinguishes them from other wood-boring beetles. Young adults are found tightly packed in the galleries in midsummer, where they remain until the following spring. There is only one generation per year.

Pest monitoring Examine branches in late spring for holes about 0.08 inch in diameter, oozing sap and sawdust. In stone fruits, these holes often are sealed with gummy ooze. Beetles particularly are attracted to unhealthy trees.

Management—cultural control

The best management tool is to keep trees healthy with proper pruning, adequate water, and fertilizer. Healthy trees repel the beetles by plugging bore holes with sap and resins. Remove and destroy infested wood on the tree or piles of infested green wood nearby, especially cherry wood. Once the bark on cut wood dries and sloughs off, it is no longer a host for the beetles. Whitewash trunks of young trees to prevent sunburn, and thus reduce potential hazard of attack by shothole borer and flathead borers.

Management—chemical control: HOME USE

Utilization of cultural techniques are typically the best management practices.

No effective insecticides are registered.

Management—chemical control: COMMERCIAL USE

No products are registered for control of this pest.

Plum and prune—Spider mite

Includes
Brown mite (*Bryobia rubrioculus*)
European red spider mite (*Panonychus ulmi*)
McDaniel spider mite (*Tetranychus mcdanieli*)
Twospotted spider mite (*Tetranychus urticae*)
Yellow spider mite (*Eotetranychus carpini borealis*)

Pest description and crop damage Several species of mites can cause damage in tree fruits. The principal mite pests of plums and prunes include the European red spider mite and the twospotted spider mite. Others are the yellow spider mite, brown mite, and McDaniel spider mite. The appearance of these mites varies with the species, although all are very small, 0.5 mm or smaller. Their color may be light yellow-greenish, red, or brownish. Mites damage fruit indirectly by feeding on leaves, which causes stippling, bronzing, and possibly leaf drop. The reduction in photosynthesis causes loss of vigor and yield.

Biology and life history Depending on species, mites overwinter as eggs or adult females under bark, on smaller branches or fruit spurs, or in

ground cover. Mites become active in the spring. There may be numerous overlapping generations per year.

Pest monitoring Observe the leaves for mites and webbing and check for the number of pest and predator mites. Typically, sufficient control is achieved by midsummer by biological agents.

Management—biological control

Phytoseiid predator mites tend to keep mites under control if broad-spectrum insecticide applications are avoided. Phytoseiid mites are similar in size to spider mites, but are shiny, more translucent, have a more pear-shaped body and move faster than spider mites. Heavy rain and cold weather also suppress mite numbers.

Management—cultural control

Broadleaf weeds like mallow, bindweed, white clover, and knotweed enhance mite numbers. Suppression of these weeds with cultivation or grasses may reduce mite numbers. Mites can be washed from the tree with a strong stream of water. Water trees properly, as drought-stressed trees are more susceptible. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control: HOME USE

Dormant-season spray

Apply only during dormant or delayed-dormant period. Use enough water to cover all the tree thoroughly including small limbs and shoots.

- horticultural mineral oil (for European red mite only)—Some formulations are OMRI-listed for organic use.
- sulfur products—Some formulations are OMRI-listed for organic use.

Growing-season spray

Some growing-season sprays can cause additional pest outbreaks and kill natural enemies. Dormant-season sprays can be effective in reducing future mite populations.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against spider mites. Some formulations are OMRI-listed for organic use.
- pyrethrins—Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

Dormant-season spray

Apply only during dormant or delayed-dormant period. Use enough water to cover all the tree thoroughly including small limbs and shoots.

- horticultural mineral oil (rates vary; check product label) (on European red mite only)—Use oil at the highest concentration only in the dormant period. REI varies; check product label. Some formulations are OMRI-listed for organic use.

Growing-season spray

- abamectin (Abamex) at 10 to 20 fl oz/A. May be applied with a horticultural mineral oil at 1 quart/100 gal (1 gal/A). REI 12 hr. PHI 21 days. Apply when mites first appear. Do not exceed two applications per season.
- bifenazate (Acramite 50WS) at 0.75 to 1 lb/A. REI 12 hr. PHI 3 days. Limited to one application per season.
- fenbutatin-oxide (Vendex 50WP) at 1 to 2 lb/A. REI 48 hr. PHI 14 days. Apply when mites first appear. Do not exceed two applications per season.
- hexythiazox (Savey 50DF) at 3 to 6 oz/A. REI 12 hr. PHI 28 days. Most effective when directed to egg stage; not effective on adults. Do not exceed one application per season.
- spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/A. REI 12 hr. PHI 7 days. Limited to one application per season.

Resistance management Always rotate products as spider mites can develop resistance rapidly to any one chemical.

Plum and prune—Spotted-wing drosophila

Drosophila suzukii

For pest description, crop damage, biology, life history, sampling and cultural management

See:

Spotted-wing Drosophila: An Emerging Berry and Stone Fruit Pest

Management—chemical control

Field research on chemical control of spotted-wing drosophila (SWD) continues under Washington and Oregon growing conditions. The best spray programs start as the fruit begins to show color and continue every 7 to 10 days through harvest. We recommend that applicators note the preharvest interval (PHI) for the chemical product selected. This spray program can start at first fly catch using a number of commercial traps designed specifically for SWD.

Management—chemical control: HOME USE

- azadirachtin (neem oil)—This product has been shown to provide about 25% control of SWD. Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- pyrethrins—These products provide about 80% control of SWD but have no residual activity. Some formulations are OMRI-listed for organic use.
- spinosad—This product generally provides 100% control and 5-7 days residual activity. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Growing-season spray

- diazinon (Diazinon 50W) at 3 to 4 lb/A. REI 4 days. PHI 21 days. Do not apply more than 4 lb product or 6 gal oil per acre per year. Do not exceed one in-season foliar application per growing season.
- imidacloprid (Prey 1.6 F, Nuprid 1.6F) at 4 to 8 fl oz/A. REI 12 hr. PHI 7 days.
- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- phosmet (Imidan 70W) at 2.13 to 4.25 lb/A. REI 7 days. PHI 14 days. Mechanical harvest permitted after 7 days post application.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.

Plum and prune—Thrips

Includes
Pear thrips (*Taeniothrips inconsequens*)
Western flower thrips (*Frankliniella occidentalis*)

Pest description and crop damage Thrips are minute, slender insects about 0.04 inch long. Adult thrips are dark brown to black in color with reddish brown eyes. The larvae are white. Most of the feeding damage occurs prior to bloom when adults feed on the fruit buds. This causes buds to dry up, die, or develop abnormally. Foliage damaged by thrips feeding appears distorted, tattered, or stunted. Fruit damaged by thrips may show surface russeting or discoloration later in the growing season.

Biology and life history Thrips overwinter as pupae in protected places on the ground. In spring, the adults fly to trees and enter developing buds to feed. Eggs are laid in the flower parts and along the mid-vein and petioles of developing leaves. The young larvae emerge to feed on the flower parts and foliage. Several generations occur each summer, and adults may feed on adjacent flowering plants as well.

Pest monitoring Thrips are monitored easily by shaking a pink bud or flower cluster into a white cup. If you find only 25 to 50 thrips per 100 buds when 50% of blossom buds show green, damage will not be too serious. In some cases, sprays for other pests will reduce the thrips population.

Management—biological control

Adults and nymphs of the minute pirate bug (*Orius* spp.) attack thrips, as do larvae of green lacewings and predaceous thrips. Cold, wet weather during bloom reduces thrips damage.

Management—cultural control

If thrips have been a problem, prune and thin after bloom, as this will dilute the populations of thrips and reduce the damage. Remove as many broadleaf flowering plants as possible from the vicinity of the trees, as these provide alternate hosts. Grass groundcovers around the trees provide competition for clovers and winter annuals that are alternate hosts.

Management—chemical control: HOME USE

Warning: Many pesticides are hazardous to bees. Look for bee precautionary statements on product labels and do not use these products during bloom or if bees are foraging in the orchard.

- azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- carbaryl—Highly toxic to bees.
- gamma-cyhalothrin—Highly toxic to bees.
- horticultural mineral oil—Some formulations OMRI-listed for organic use.
- imidacloprid—Highly toxic to bees. Soil drenches may have residual activity in woody plants lasting for 12 or more months. If short-term management is the goal, consider other approaches.
- insecticidal soap—Some formulations are OMRI-listed for organic use.
- kaolin—Applied as a spray to leaves, stems, and fruit, it acts as a repellant to some insect pests. Some formulations are OMRI-listed for organic use.
- lambda-cyhalothrin—Highly toxic to bees.
- plant-derived essential oils—Some have shown efficacy against thrips. Some formulations are OMRI-listed for organic use.
- pyrethrins (often as a mix with other ingredients)— Highly toxic to bees. Some formulations are OMRI-listed for organic use.
- spinosad—Toxic to bees. Some formulations are OMRI-listed for organic use.

- zeta-cypermethrin—Highly toxic to bees.

Management—chemical control: COMMERCIAL USE

Spring and summer spray

- lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/A. REI 24 hr. PHI 14 days. May disrupt beneficial mite populations. Extremely toxic to fish; avoid spray drift and surface runoff.
- spinetoram (Delegate WG) at 4.5 to 7 oz/A. REI 4 hr. PHI 1 day. Apply no less than one week apart, with a maximum of 4 applications per season.
- spinosad (Entrust SC) at 4 to 8 fl oz/A. REI 4 hr. PHI 1 day. Results are best when applied at petal fall. May act slowly. OMRI-listed for organic use.
- thiamethoxam+chlorantraniliprole (Voliam Flexi) at 6 to 7 oz/A. Do not apply exceed 14 oz/A of Voliam Flexi per season. REI 12 hr. PHI 14 days.