

Nut Crops

Chestnut Pests

Neil Bell and Nik Wiman

Latest revision—March 2018

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

Chestnut—Filbertworm

Cydia latiferreana

Pest description and crop damage Adult moths have a wingspread of about 0.5 inch. Moths are gray to reddish with golden bands across each forewing. When full grown, larvae are whitish with a translucent, amber-colored head, 0.5 inch long. The larvae feed within the nut and destroy the kernel.

Biology and life history The filbertworm overwinter as larvae in silken cocoons, which may be found under leaves and leaf litter on the ground, or in cracks and crevices in bark. Some larvae also hibernate 1 to 2 inches beneath the soil surface. The larvae pupate, then the adults emerge beginning in mid-June. Moth emergence continues through October. After emergence, the adults find mates and lay eggs singly near developing nuts. Eggs mature in 8 to 10 days, and the larvae then move about in search of a nut to feed on. They burrow into the nut, feed on the kernel for 2 to 4 weeks, and bore their way back out. Most form cocoons to overwinter, although there may be a partial second generation.

Scouting and thresholds Pheromone traps are used to time sprays for this pest. A degree-day model is available on www.uspest.org.

Management—chemical control: HOME USE

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl—Do not apply to blooming trees or weeds or cover crops in bloom. Deadly to bees. Apply early July and again 3 weeks later.
- ◆ gamma-cyhalothrin
- ◆ lambda-cyhalothrin
- ◆ pyrethrins—Some formulations are OMRI-listed for organic use.
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL

Pheromone trapping is encouraged for accurate spray timing.

- ◆ alpha-cypermethrin (Fastac CS) at 3.2 to 3.8 fl oz/a. PHI 7 days. REI 12 hr. Do not exceed 11.4 fl oz/a per season. Highly toxic to bees, extremely toxic to fish and aquatic invertebrates. Do not apply within 25 feet of aquatic habitats, or within 150 ft if aerial application. Apply as indicated by scouting.
- ◆ acetamiprid (Assail 70WP) at 2.3 to 4.1 oz/a. PHI 14 days. No more than 4 applications per season.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.016 to 0.19 lb ai/a. Maximum per 14 days and per season: 0.022 lb ai/a. PHI 14 days.
- ◆ beta-cyfluthrin + imidacloprid (Leverage 360) at 2.8 fl oz/a. Maximum 2.8 fl oz/a per year. PHI 14 days.
- ◆ bifenthrin—
 - Brigade WSB at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
 - Fanfare EC at 3.2 to 12.8 fl oz/a. PHI 7 days. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
- ◆ buprofenzin (Tourismo) at 10 to 14 fl oz/a. Do not apply more than 3 applications or 37 oz/a per season. Retreatment interval 7 days. PHI 60 days.
- ◆ carbaryl (Sevin XLR Plus or its equivalent in another formulation) at 0.5 to 1.25 quarts/100 gal water (2 to 5 quarts/a). PHI 14 days. REI 12 hr. May cause rapid increase of aphid populations 3 to 4 weeks after application. Extremely toxic to aquatic invertebrates.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 75 WG at 2 to 2.67 lb/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (22 to 57 fl oz/a). PHI 14 days. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for filbertworm.
- ◆ *Chromobacterium subsugae* strain PRAA4 (Grandevo) at 1 to 3 lb/a. OMRI-listed for organic production.
- ◆ deltamethrin (Delta Gold) at 0.02 to 0.033 lb ai/a. Retreatment interval 7 days. Maximum of 0.165 lb ai/a per growing season. PHI 21 days.
- ◆ diflubenzuron (Dimilin 2L) at 16 fl oz/a. Most effective if applied before egg-laying. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water. Do not make more than 4 applications per season. PHI 28 days. REI 12 hr.
- ◆ dodecadien (Checkmate)—Mating disruption. See label for application rates. Studies in apple indicate that a minimum of 10 acres is required for successful treatment. OMRI-listed for organic production.
- ◆ emamectin benzoate (Proclaim) at 3.2 to 4.8 oz/a. PHI 14 days.
- ◆ esfenvalerate (Asana XL) at 8 to 10 fl oz/100 gal water (10 to 19.2 fl oz/a). PHI 21 days. REI 12 hr. Do not apply more than 0.2 lb ai/a per season. Extremely toxic to fish and aquatic habitat.
- ◆ flubendiamide (Belt) at 3 to 4 fl oz/a. PHI 14 days. REI 12 hrs.
- ◆ lambda-cyhalothrin (Warrior II) at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
- ◆ lambda-cyhalothrin+chlorantraniliprole (Voliam Express) at 6 to 12.5 fl oz/a. Retreatment interval 7 days. PHI 14 days. Do not exceed 31 fl oz (0.16 lb ai/a) of lambda-cyhalothrin-containing products per season.

- ◆ lambda-cyhalothrin+thiamethozam (Endigo ZC) at 5 to 6 fl oz/a. See label for restrictions. PHI 14 days.
- ◆ methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/a. PHI 14 days. REI 4 hr. Apply when egg hatch begins. Reapply at 14- to 21-day intervals under high pressure or sustained moth flight. Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- ◆ permethrin—
 - Ambush 25W at 12.8 to 25.6 oz/a. PHI 14 days. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - Ambush at 0.2 to 0.4 lb ai/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - Pounce 3.2 EC at 8 to 16 oz/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
- ◆ pyriproxyfen (Esteem 35 WP) at 4 to 5 oz/a. Do not apply more than twice per season. PHI 21 days. REI 12 hr.
- ◆ spinetoram (Delegate WG) at 1.3 to 1.75 oz/100 gal water (4.5 to 7 oz/a). PHI 14 days. REI 4 hr. Apply no less than one week apart, with a maximum four applications per season.
- ◆ spinosad (Success 2L) at 1 to 2.5 oz/100 gal water (4 to 10 oz/a). PHI 14 days. Do not exceed 29 oz/a per season.
- ◆ spinosad (Entrust SC) at 4 to 10 oz/a. PHI 1 day. REI 4 hr. OMRI-listed for organic use.
- ◆ tebufenozide (Confirm 2F) at up to 30 oz/a. PHI 14 days. REI 12 hr. Apply when egg hatch begins. Do not exceed 30 oz/a per application or 122 oz/a for the season.
- ◆ zeta-cypermethrin (Gladiator)—See label for rates. PHI 21 days.

Chestnut—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 nut trees. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees also may be attacked. Chestnut trees growing adjacent to woodlands are also at risk. 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. Larvae and adults 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 there, then adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. They 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 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. This activity creates many small, round exit holes that produce a “shothole” effect. There are two generations per year.

Scouting and thresholds Examine branches in late spring for holes 0.08 inch in diameter, oozing sap and sawdust. Beetles are especially attracted to unhealthy trees.

Management—cultural control

The best management tool is keeping trees healthy through proper pruning, adequate watering, and fertilizing. Healthy trees repel the beetles by plugging bore holes with sap and resins. Remove and destroy infested wood on the tree or nearby piles of infested green wood, 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 reduce potential hazard of attack from shothole borer. Tanglefoot or other sticky substances applied to the trunk may be effective. Yellow sticky traps are effective for trapping these beetles.

Management—chemical control: HOME USE

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

Management—chemical control: COMMERCIAL USE

- ◆ fenpropathrin (Danitol 2.5EC) at 10 to 21 oz/a (0.2 to 0.4 lb ai/a). PHI 3 days.

Hazelnut Pests

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

Hazelnuts are wind pollinated but it is still important to be aware of pollinator activity in and around the orchard. Bees sometimes forage on hazelnut pollen and they can be present in the orchard throughout the growing season foraging on flowering weeds and hedgerows. Infestations of sucking insect pests such as aphids and scale produce honeydew, which can be highly attractive to pollinators. Take extra care to protect pollinators when utilizing flowering cover crops in orchards. Note bee warnings on pesticide labels and time applications to avoid bee kills.

The following suggests the amount of each spray material 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 that is to be used. Under present federal regulations, it is unlawful to apply any pesticide in a manner, rate, or dilution that is not so prescribed on the label. Check with the county agent or Agricultural Research Center in your area if there are any discrepancies between the recommendations in this handbook and a pesticide label. Practice integrated pest management (IPM) principals and avoid unnecessary or

prophylactic insecticide use. Use scouting and monitoring to determine whether pest problems justify management.

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

Hazelnut—Aphid

Filbert aphid (*Myzocallis coryli*)

Hazelnut aphid (*Corylobium avellanae*)

Pest description and crop damage Medium to small greenish aphids that feed on leaves (primarily filbert aphid) and husks (primarily hazelnut aphid), causing honeydew. Infestations reduce percent fill and size of nut. Experimental evidence indicates that heavy infestations of aphids should be controlled. Damage caused by aphids is cumulative; benefits might not be seen during the first season of treatment but become evident after two years or more of aphid control.

Biology and life history The aphid overwinters as eggs on twigs. In early spring, eggs hatch, and the aphids feed on buds before moving to the leaves. The population can increase rapidly, and there are many generations per year. In the fall, sexual forms are produced which lay overwintering eggs.

Pest monitoring The sampling period is April 1–Sept 30. Check three terminal branches per tree and three leaves per terminal. Count the number of aphids per leaf and treat when the following thresholds are reached: April: 20/leaf, May: 30/leaf, June: 40/leaf, and July: 40/leaf with an increasing population. If there are signs of the parasitoid, *Trioxys pallidus*, hold off treatment and check back on population levels in a week. Mummified aphids indicate that the parasitoid is active. The mummies will appear swollen, rounded and darker and may have an exit hole chewed by the wasp.

Management—biological control

A parasitic wasp (*Trioxys pallidus*) of this aphid has become well established in the Willamette Valley. This biological control makes aphid sprays unnecessary in many hazelnut orchards. Pest management that is detrimental to the wasp population can aggravate aphid problems.

Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. *Home orchardists:* Wash aphids from plants with a strong stream of water or by hand-wiping. Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth. Control ants, which “farm” the aphids for their honeydew and protect them from predators.

Management—chemical control: HOME USE

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ imidacloprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ insecticidal soap—Some formulations OMRI-listed for organic use.
- ◆ kaolin—Some formulations are OMRI-listed for organic use.

- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against aphids.
- ◆ 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

- ◆ acetamiprid (Assail 70WP) at 1.1 to 4.1 oz/a. PHI 14 days. REI 12 hr. No more than 4 applications per season.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 75WG at 2 to 2.67 lb/a. PHI 14 days. REI 1 day. No more than three applications per season. Do not graze livestock in the treated area. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 1 day. No more than three applications per season. Do not graze livestock in the treated area. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (26 to 57 fl oz/a). PHI 14 days. REI 1 day. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ chlorpyrifos + O-diethyl-O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate (Vesper, Vulcan) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not make more than 3 applications per season.
- ◆ diazinon (Diazinon AG 500) at 1 pint/250 to 400 gal water/a. No more than one application per season. PHI 45 days. REI 18 days. Washington and Oregon only.
- ◆ flupyradifurone (Sivanto) at 7.0 to 10.5 fl oz/a. PHI 7 days. REI 4 hr. Use no more than 28 fl oz/acre/year.
- ◆ imidacloprid (Provado 1.6) at 3.4 to 7 fl oz/a. PHI 7 days. REI 12 hr. Generic labels for imidacloprid are available.
- ◆ imidacloprid + beta-cyfluthrin (Leverage 360) at 2.8 oz/a. PHI 14 days. REI 12 hr.
- ◆ imidacloprid + cyfluthrin (Leverage 2.7) at 3.8 to 5.1 oz/a. PHI 14 days. REI 12 hr.
- ◆ spirotetramat (Movento) at 6 to 9 fl oz. PHI 7 days. REI 1 day.
- ◆ sulfoxaflor (Closer SC) at 1.5 to 2.75 oz/a. PHI 7 days. REI 12 hr.

Hazelnut—Brown Marmorated Stink Bug

Halyomorpha halys

Pest description and crop damage An invasive pest that an increasing problem on hazelnuts in the Willamette Valley. There are five immature stages, and all but the first can feed on hazelnut trees. Feeding may be on vegetative structures or on nuts (shell thickness or hardness does not protect kernels from feeding damage). Vegetative feeding may not be problematic on its own, but the later instar nymphs and adults can damage kernels, and depending on when the damage occurs, they can cause blank nuts, shrivel or corking damage on the kernels. (See OSU EM 9102: How to recognize brown marmorated stink bug damage in commercial hazelnuts as a guide to hazelnut damage.)

Biology and life history

See EMERGING PEST: Brown Marmorated Stink Bug—A Pending Threat to Pacific Northwest Agriculture.

Pest monitoring Pheromone traps, visual samples, or beating trays are good methods for detection. (See OSU EM 9138: How to monitor for brown marmorated stink bug in specialty crops.) Place traps on orchard borders and monitor orchard border vegetation. Management thresholds based on trap captures or other sampling

methods are not yet firmly established, but trap captures of adults in the orchard may represent a damaging population. Presence of nymphs in the crop can also be an indicator that damage will occur. Stink bugs are very cryptic and can be difficult to detect in the crop. Slow movement when scouting can be important to detect nymphs without triggering a hiding or flight response. Scan the underside of leaf surfaces for egg masses and early nymphs. Standardize the amount of time spent visually searching for stink bugs (e.g., two minutes) to compare samples from different times of the season or locations. Note that the highest pressure from this pest will be late in the season (Aug thru Oct), although damaging levels may also occur early in the season.

Management—biological control

An adventive parasitoid wasp from Asia, *Trissolcus japonicus*, was detected in Portland, Oregon in 2016. This parasitoid is expected to eventually become widespread, and there is a current effort to redistribute it. This wasp attacks the eggs and is very effective against brown marmorated stink bug in Asia. Native parasitoids and predators can also help limit populations, but are not effective enough to keep populations in check.

Management—cultural control

Hand collecting and killing of egg masses, nymphs, and adults can be an effective management strategy if there are very few trees, but this method is not practical on a commercial scale. Eliminating or excluding aggregations of adults in their overwintering sites, including farmhouses and out buildings, may be beneficial to reduce local populations for commercial growers and homeowners.

Management—chemical control: HOME USE

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against aphids.
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

- ◆ acetamiprid (Assail 70WP) at 0.57 to 1 oz/100 gal water (2.3 to 4.1 oz/a). PHI 14 days. No more than 4 applications per season.
- ◆ bifenthrin—
 - Brigade WSB at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
 - Fanfare EC at 3.2 to 12.8 fl oz/a. PHI 7 days. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
- ◆ cyfluthrin (Baythroid XL) at 2 to 2.4 oz/a. PHI 14 days. REI 12 hr.
- ◆ diflubenzuron + lambda-cyhalothrin (DoubleTake) at 4 to 5 fl oz/a. PHI 28 days. REI 24 hr. Do not exceed 20 fl oz/a per growing season or 15 fl oz/a per year growing season post bloom. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water, 150 ft if applied by air.
- ◆ imidacloprid (Admire Pro 1.6) at 1.2 to 2.4 fl oz/a. PHI 7 days. REI 12 hr. Generic labels for imidacloprid are available.

- ◆ lambda-cyhalothrin—
 - Warrior II at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - LambdaStar at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - Grizzly Too at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - Drexel L-C at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.

Hazelnut—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 up to 1 inch long.

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). This pest is infrequent in commercial hazelnuts.

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

Management—chemical control: HOME USE

- ◆ spinosad

Management—chemical control: COMMERCIAL USE

- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 75 WG at 2 to 2.67 lb/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (26 to 57 fl oz/a). PHI 14 days. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ chlorpyrifos + O-diethyl-O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate (Vesper, Vulcan) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not make more than 3 applications per season.

Hazelnut—Big bud mite

Phytocoptella avellanae

Cecidophyopsis vermiformis

Pest description and crop damage Microscopic eriophyid mites that feed on and within leaf and flower buds and catkins. Buds swell to large size before they die and fall off. Bud mites are more of a problem in some legacy hazelnut varieties, especially Ennis, Willamette, Daviana and Royal. The OSU hazelnut breeding program selects against bud mites so blasted buds are less common in recent cultivar releases. Infested buds do not produce nuts and can cause vegetative growth abnormalities.

Pest monitoring Time sprays to intercept mites as they migrate from blasted buds to new buds in early spring. Monitoring is accomplished by placing double-sided sticky tape or tacky insect

glue on branches below blasted buds and counting trapped mites under magnification at regular intervals. Timing sprays for peak mite migration is most effective. Eriophyid mite populations can be controlled by predatory mites and mite flaring may be linked to use of broad-spectrum insecticides and loss of biological control. Most materials labeled for bud mite cannot be applied by air.

Management—biological control

Releases of predatory mites (*Galendromus* spp.) may have efficacy against these mites.

Management—chemical control: HOME USE

No products are registered for home use for this pest.

Management—chemical control: COMMERCIAL USE

- ◆ abamectin (Abamex) at 10 to 20 oz/ac. REI 12 hr. Do not exceed two applications per season. May have low efficacy.
- ◆ calcium polysulfide (Sulforix) at 3 gal/a. REI 2 days.
- ◆ lime-sulfur (BSP) at 12 gal/a. REI 2 days.
- ◆ pyridaben (Nexter) at 2.67 oz/100 gal water (10.67 oz/a). PHI 7 days. Do not exceed two applications per season. May have low efficacy.
- ◆ spiroticlofen (Envidor 2SC) at 16 to 18 fl oz/a. PHI 7 days. REI 12 hr. May have low efficacy.
- ◆ fenpyroximate (Fujimite XLO) at 2 to 4 pints/a. PHI 14 days. REI 12 hr.

Hazelnut—Filbert leafroller

Archips rosana

Pest description and crop damage Adult moths are 0.5 to 0.75 inch long, dark brown, with darker transverse lines on the forewings. The larvae are green with a light to dark brown head. Damage begins early in spring and includes rolling of leaves as well as feeding on foliage and buds. There is one generation each season.

Biology and life history This leafroller overwinters as eggs laid on the bark or limbs in irregular flat masses which appear grayish by spring. 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 on twigs and branches in July.

Pest monitoring Start checking for larvae around mid-March by inspecting three terminals per tree and three leaf clusters per terminal. Each terminal is a sampling unit. The terminal clusters should be examined for tightly rolled leaves and feeding damage on new growth. Check for adults by using one pheromone trap for each 5 acres, placed 6 ft high in the tree canopy starting in mid-May. Treat for larvae when infestation level is 20 to 25%. Treat for adults when catch is 40 moths per week.

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. Typically, biological control is sufficient to manage leafrollers and chemical control is rarely necessary.

Management—cultural control

Home orchardists: Hand-pick rolled leaves containing larvae or pupae.

Management—chemical control: HOME USE

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.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against aphids.
- ◆ 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

Make spray application in spring after overwintering eggs hatch, about the time leaves are about 0.75 to 1 inch. Control is more effective if pesticide is applied when larvae are small.

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Apply with spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ diflubenzuron (Dimilin 2L) at 12 to 16 fl oz/a. PHI 28 days. REI 12 hr. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water.
- ◆ emamectin benzoate (Proclaim) at 3.2 to 4.8 oz/a. PHI 14 days. REI 12 hr.
- ◆ flubendiamide (Belt) 3 to 4 fl oz/a. PHI 14 days. REI 12 hr.
- ◆ methoxyfenozide (Intrepid 2F) at 8 to 16 fl oz/a. PHI 14 days. REI 4 hr. For control of foliar feeding leafroller larvae, apply when larvae are feeding. Most effective crop protection results from application made at the initiation of egg hatch. Do not apply more than 24 fl oz/a per application or 64 fl oz/a (1 lb ai) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- ◆ pyriproxyfen (Esteem 35 WP) at 4 to 5 oz/100 gal water. Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spinetoram (Delegate WG) at 1.1 to 1.75 oz/100 gal water (4.5 to 7 oz/a). PHI 14 days. Apply no less than one week apart, with a maximum of 28 oz/per year.
- ◆ spinosad (Success 2L, Entrust SC) at 4 to 10 fl oz/a. PHI 1 day. REI 4 hr. Do not apply more than 29 fl oz/a per year. Entrust SC is OMRI-listed for organic use.

Hazelnut—Filbertworm

Cydia latiferreana

Pest description and crop damage This insect is the key pest of hazelnuts in the Pacific Northwest. It is a close relative of codling moth, one of the most economically significant insects worldwide. Adult moths are gray to reddish with golden bands across each forewing. Larvae feed within the nut and destroy the kernel. When fully developed, the larvae are whitish with a brown headcapsule and are approximately 0.5 inch long. The entry hole into the shell is not often seen, but the much larger exit hole is apparent after the larvae has finished devouring the kernel.

Biology and life history The insect is found in many wild and cultivated nuts in North America but is particularly common in acorns and hazelnuts. The filbertworm overwinters as a larva in a silken cocoon. These are found under leaves and debris on the ground or in cracks and crevices on trees. Some larvae also overwinter 1 to 2 inches beneath the soil surface. The larvae pupate and the adults begin to emerge mid-June through October. After mating the female moths begin to lay single eggs near developing nuts. Eggs hatch in 8 to 10 days, and the tiny larvae search out nuts. They burrow into the nut to feed on the kernel for 2 to 4 weeks before they bore their way out. Most then form cocoons (hibernaculae) to overwinter, although some may pupate and become moths within the season (i.e., there may be a partial second generation). Sprays are timed to target the eggs and the wandering early larvae before they penetrate the nuts. Note that spray timing is critical when selecting materials with lower residual, use the degree day model available from the Integrated Plant Protection Center: <http://uspest.org/wea/>.

Pest monitoring Filbertworm flight has been starting earlier in the season compared to historic norms. Previous recommendations were to start hanging pheromone traps before the flight of filbertworm moths begins in mid-June, but now it is clear that traps should be placed mid-May to capture the first moths. Use four traps for the first 10 acres and one for each additional 4 acres. Place the traps in the upper third of the canopy. The action threshold is 2-3 moths per trap or five moths in any one trap. Note that very early moth flight may not threaten the crop if there are no nuts present. Apply insecticides 8–12 days after filbertworm moths emerge in your orchard block to target larvae emerging from eggs prior to nut penetration (first egg hatch occurs when 955 degree days have accumulated after April 1). A second application may be necessary in 2–3 weeks, or if moths continue to be caught in traps at rates above the threshold. Moths flying late in the season can cause unexpected crop damage so it is important to keep monitoring through harvest.

Management—mating disruption

Isomate FBW ring (Pheromone)—OMRI approved for organic use. Apply dispensers in the upper 1/3 of the canopy before first moth flights at a minimum of 20 dispensers per acre. Minimum block size of 10 acres. Renew dispensers each season and continue to monitor traps.

Management—chemical control: HOME USE

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI minimum of 7 days.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ pyrethrins

- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Filbertworm emergence notices are sent to growers. Time sprays accordingly. Pheromone trapping is encouraged for accurate spray timing.

- ◆ alpha-cypermethrin (Fastac CS) at 3.2 to 3.8 fl oz/a. PHI 7 days. REI 12 hr. Do not exceed 11.4 fl oz/a per season. Highly toxic to bees, extremely toxic to fish and aquatic invertebrates. Do not apply within 25 feet of aquatic habitats, or with 150 ft if aerial application. Apply as indicated by scouting.
- ◆ acetamiprid (Assail 70WP) at 0.57 to 1 oz/100 gal water (2.3 to 4.1 oz/a). PHI 14 days. No more than 4 applications per season.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 75 WG at 2 to 2.67 lb/a. PHI 14 days. REI 1 day. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (26 to 57 fl oz/a). PHI 14 days. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ chlorpyrifos + O-diethyl-O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate (Vesper, Vulcan) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not make more than 3 applications per season.
- ◆ chlorantraniliprole (Altacor) at 3 to 4.5 oz/a. PHI 10 days. REI 4 hr.
- ◆ cyfluthrin (Baythroid XL) at 2 to 2.4 oz/a. PHI 14 days. REI 12 hr.
- ◆ diflubenzuron (Dimilin 2L) at 12 to 16 fl oz/a. PHI 28 days. REI 12 hr. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water.
- ◆ emamectin benzoate (Proclaim) at 3.2 to 4.8 oz/a. PHI 14 days.
- ◆ esfenvalerate (Asana XL) at 8 to 12 fl oz/100 gal water (10 to 18 fl oz/a). PHI 21 days. REI 12 hr. Do not apply more than 0.2 lb ai/a per season. Extremely toxic to fish and aquatic habitat.
- ◆ esfenvalerate (S-fenvaloStar) at 9.6 to 12.8 fl oz/100 gal water (10 to 18 fl oz/a). PHI 21 days. REI 12 hr. Do not apply more than 0.2 lb ai/a per season. Extremely toxic to fish and aquatic habitat. Apply with first filbertworm moth flight in early summer, do not apply second treatment within 3 weeks. Do not apply more than 0.2 lb ai per season. Highly toxic to bees, fish, and aquatic invertebrates.
- ◆ flubendiamide (Belt) 3 to 4 fl oz/a. PHI 14 days. REI 12 hr.
- ◆ lambda-cyhalothrin—
 - Warrior II at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - LambdaStar at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - Grizzly Too at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - Drexel L-C at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
- ◆ methoxyfenozide (Intrepid 2F, Troubadour 2F) at 8 to 16 fl oz/a. PHI 14 days. REI 4 hr. Apply when egg hatch begins. Reapply at 14 to 21 day intervals under high pressure or sustained moth flight. Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

- ◆ permethrin—
 - Ambush 25W at 12.8 to 25.6 oz/a. PHI 14 days. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - Ambush 2E at 0.8 to 1.6 pints/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - Pounce 3.2 EC at 0.5 to 1 pint/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - PermaStar AG at 8 to 16 oz/a. PHI 14 days. REI 12 hr. Highly toxic to bees, toxic to fish and aquatic invertebrates.
- ◆ pyriproxyfen (Esteem 35 WP) at 4-5 oz/100 gal water. Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spinetoram (Delegate WG) at 1.5 to 1.75 oz/100 gal water (4.5 to 7 oz/a). PHI 14 days. Apply no less than one week apart, with a maximum 4 applications per season.
- ◆ spinosad (Success 2L) at 1 to 2 oz/100 gal water (4 to 8 oz/a.) PHI 1 day. Do not exceed 29 oz/a per season.
- ◆ spinosad (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
- ◆ tebufenozide (Confirm 2F) at up to 30 oz/a. PHI 14 days. REI 12 hr. Apply when egg hatch begins. Do not exceed 30 oz/a per application or 122 oz/a for the season.

Hazelnut—Obliquebanded leafroller

Choristoneura rosaceana

Pest description and crop damage Bright green caterpillar with a black or brown head. Larvae roll leaves together using silk to create protected feeding sites. When these sites are located near developing nuts, feeding damage to the nuts can occur. Adult moths are bell-shaped, up to 1 inch long, tan to brown, with broad bands on the wings. Their appearance is very similar to omnivorous leafroller, although the omnivorous leafroller has a more pronounced bell shape to the wings when viewed from above.

Biology and life history There are two generations of obliquebanded leafroller each season, occurring from May through harvest. Early stage (minute) larvae overwinter under the bark on scaffold branches of a variety of host plants and may feed during warm periods in winter but become active in spring with onset of new growth. Larvae exhibit a characteristic rapid backwards wiggle from the feeding site when disturbed. They feed for several weeks in the leaves, typically forming a new feeding site prior to pupation. Adult moths emerge in late June to July. These moths lay eggs for the second generation. The second generation hatches in early July. Larvae feed on leaves but may occasionally damage nuts if their feeding site happens to be within a nut cluster or in direct contact with a nut cluster.

Pest monitoring Start checking for larvae around mid-March by inspecting three terminals per tree and three leaf clusters per terminal. Each terminal is a sampling unit. Check for adults by using one pheromone trap for each 5 acres, placed 6 ft high in the tree canopy starting in mid-May. Treat larvae when infestation level is 20 to 25%. Treat for adults when catch is 40 moths per week and larvae are feeding on nuts. The first flight usually is in June. Spray when pheromone traps catch five to eight moths over a 3-day period. The second flight usually is in September.

Management—biological control

Obliquebanded leafroller larvae are targeted by a wide variety of specialist and generalist parasitoids that normally keep populations under control after the spring generation. Sprays are rarely necessary. Examine feeding sites of mature larvae to get an idea of natural enemy activity. Small cocoons or caterpillars being

consumed by small larvae indicate active biocontrol. Conserve natural enemies through judicious insecticide use, but monitor leafroller numbers as population build-up can be rapid.

Management—chemical control: HOME USE

If necessary, spray in spring after overwintering larvae emerge, around the time leaves are 0.75 to 1 inch long. Control is much more effective if sprays are applied when larvae are small but these young larvae are the most difficult to detect.

- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against aphids.
- ◆ 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

- ◆ alpha-cypermethrin (Fastac CS) at 3.2 to 3.8 fl oz/a. PHI 7 days. REI 12 hr. Do not exceed 11.4 fl oz/a per season. Highly toxic to bees, extremely toxic to fish and aquatic invertebrates. Do not apply within 25 feet of aquatic habitats, or with 150 ft if aerial application. Apply as indicated by scouting.
- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Apply with spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ chlorantraniliprole (Altacor) at 3 to 4.5 oz/a. PHI 10 days. REI 4 hr.
- ◆ emamectin benzoate (Proclaim) at 3.2 to 4.8 oz/a. PHI 14 days.
- ◆ esfenvalerate (Asana XL) at 8 to 12 fl oz/100 gal water (10 to 18 fl oz/a). PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Extremely toxic to fish and aquatic habitat.
- ◆ esfenvalerate (S-fenvaloStar) at 9.6 to 12.8 fl oz/100 gal water (10 to 18 fl oz/a). PHI 21 days. REI 12 hr. Do not apply more than 0.2 lb ai/a per season. Extremely toxic to fish and aquatic habitat. Apply with first filbertworm moth flight in early summer, do not apply second treatment within 3 weeks. Do not apply more than 0.2 lb ai per season. Highly toxic to bees, fish, and aquatic invertebrates.
- ◆ flubendiamide (Belt) 3 to 4 fl oz/a. PHI 14 days. REI 12 hr.
- ◆ lambda-cyhalothrin—
 - Warrior II at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - LambdaStar at 2.56 to 5.12 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - Grizzly Too at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.

- ◆ methoxyfenozide (Intrepid 2F, Troubadour 2F) at 0.12 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
 - *Spring (overwintering) generation*—Apply once or twice, depending on infestation level.
 - *Summer generation*—Apply first during the period of peak egg lay to early egg hatch (200 to 400 DD, following biofix). Reapply 10 to 18 days later (usually 500 to 700 DD). Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- ◆ permethrin—
 - Ambush 25W 12.8 to 25.6 oz/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - Pounce 3.2 EC at 0.5 to 1 pint/a. PHI 14 days. REI 12 hr. Do not graze treated orchards. Extremely toxic to fish and aquatic habitat.
 - PermaStar AG at 8 to 16 oz/a. PHI 14 days. REI 12 hr. Highly toxic to bees, toxic to fish and aquatic invertebrates.
- ◆ pyriproxyfen (Esteem 35 WP) at 4 to 5 oz/100 gal water. Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spinetoram (Delegate WG) at 1.5 to 1.75 oz/100 gal water (4.5 to 7 oz/a). PHI 14 days. Apply no less than one week apart, with a maximum 4 applications per season.
- ◆ spinosad (Success 2L, Entrust SC) at 4 to 10 fl oz/a. PHI 14 days. REI 4 hr. Do not exceed 29 fl oz/a per year. Entrust SC is OMRI-listed for organic use.

Hazelnut—Omnivorous leaf-tier

Cnephasia longana

Pest description and crop damage Adult female moths are grayish and mottled with brown spots. The male moth is grayish yellow. Larvae are a dirty yellow color. Larvae appear in early spring and roll and feed on leaves or inside buds. The larvae web leaves and flowers together and feed on developing buds, often resulting in destruction of the terminal growth. This pest is rarely a problem in hazelnut orchards.

Pest monitoring Pry open buds at the time of bud break and look for larvae. Treat when you reach a 5% infestation level of buds checked. This pest has not been a problem in recent years.

Management—chemical control: HOME USE

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

Management—chemical control: COMMERCIAL USE

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Apply with spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ carbaryl (Sevin XLR Plus) at 2 to 5 quarts/a. 4F and 80S formulations are also available. PHI 14 days. REI 12 hr. Extremely toxic to aquatic invertebrates and bees.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
- ◆ chlorpyrifos (Lorsban 4E) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. No more than three applications per season. This pest is a problem only on first- to third-leaf trees. More than one application may be required due to re-infestation. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos (Lorsban 75 WG) at 2 to 2.67 lb/a. PHI 14 days. REI 24 hr. No more than three applications per season. This pest is a problem only on first- to third-leaf trees. More than one

application may be required due to re-infestation. Extremely toxic to fish. Toxic to birds and wildlife.

- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (26 to 57 fl oz/a). PHI 14 days. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ chlorpyrifos + O-diethyl-O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate (Vesper, Vulcan) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not make more than 3 applications per season.
- ◆ diflubenzuron (Dimilin 2L) at 12 to 16 fl oz/a. PHI 28 days. REI 12 hr. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water.
- ◆ diflubenzuron + lambda-cyhalothrin (DoubleTake) at 4 to 5 fl oz/a. PHI 28 days. REI 24 hr. Do not exceed 20 fl oz/a per growing season or 15 fl oz/a per year growing season post bloom. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water, 150 ft if applied by air.
- ◆ methoxyfenozide (Intrepid 2F, Troubadour 2F) at 0.12 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. To control foliar-feeding leafroller larvae, apply when larvae are feeding. Most effective crop protection results from application when egg hatch begins. Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.

Hazelnut—Pacific flatheaded borer

Chrysobothris mali

Pest description and crop damage The Pacific flatheaded borer is a pest of many different trees and shrubs, including fruit trees and hazelnuts. In hazelnuts, flatheaded borer has been a problem in young orchards, where small trees are attacked and often killed. Adults are metallic reddish bronze beetles with copper-color spots on wing covers, and about 0.25 to 0.5 inch long. The adult beetle is rarely observed and it is not destructive although some minor feeding on leaf margins may occur. The females lay their eggs on the trunk of young hazelnut trees, and the larvae enter the wood, boring out the cambium as they feed. Larvae are whitish to pale yellow and about 0.5 inch long when fully developed. The head is enlarged and flattened giving the “flat-headed” appearance. Larval feeding beneath the bark can result in partial or complete girdling and subsequent tree death. It can take time for the tree to completely die. The feeding site obstructs the flow of water and nutrients from the roots to the leaves and branches. This can worsen drought stress on the tree during hot and dry weather because the tree cannot replenish canopy moisture effectively. A symptom of borer-infested trees is excessive wilting, yellowing and other signs of stress in individual trees during hot periods. The borers have already done most of their damage by the late season and the symptoms of girdling will be most apparent in the leaves and appearance of the tree at that time. Trees that are exhibiting these symptoms should be examined for borer damage starting at the soil line and up the trunk to height of approximately 2.5 feet. If the stresses of a partial girdle do not kill the tree, then there are serious risks that the tree will ultimately snap off as it grows top heavy and begins to put on a nut crop.

Biology and life history The phenology of the pest is not well-known for western Oregon. Adults emerge from wood starting in late May/early June and emergence continues through early August. Adults fly and mate and females seek out host trees to attack. The female lays the egg in imperfections on the bark, and the larvae hatches from the egg and bores into the tree, mining mostly the cambium layer. The larvae have done most of the damage by the end of the growing season and they may move to the middle of the trunk to overwinter in the larval stage. In the spring, the larvae pupate and the adult chews its way out of the host. Some larvae

may remain in the wood and emerge the following season.

Pest monitoring Stunted leaves and wilting in the upper canopy of young trees while vigorous suckers or watersprouts are growing are a good indicator of girdling of the main trunk by Pacific flatheaded borer. Catkins may form but never distend. Sawdust frass may be apparent on the soil around the base of the tree, especially when trunk guards are removed. Watch for depressions in the bark or cracks through which frass may be seen. The thin bark of hazelnuts will eventually peel back to reveal the mined out feeding sites. The damage may resemble mechanical or rodent damage, but inspect for shallow galleries where the larvae were feeding and evidence of frass. Dead sticks can be flexed and the wood will typically break at the weak point where the larvae were feeding.

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

Young, recently planted trees are most susceptible. Trees that are stressed because of drought or other causes are especially vulnerable.

Beetles are attracted to weakened, sunburned, or injured parts of trunks and lay eggs in cracks on bark exposed to the sun. Plastic trunk guards and paint do not prevent attack on trunks of young hazelnut trees. However, these can help prevent sunburn and mechanical damage on trunks, which create weak imperfections that the adult beetles can exploit for egg laying. Minimize drought stress on young trees with irrigation. Avoid pruning watersprouts, branches and suckers on young trees during flight periods.

Sanitize orchards by removing infested wood and burning it.

Management—chemical control: HOME USE

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

Management—chemical control: COMMERCIAL USE

- ◆ chlorpyrifos (Lorsban 4E) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. No more than three applications per season. Extremely toxic to fish. Toxic to birds and wildlife. Trunk sprays or cover sprays (trunk sprays will be less disruptive).
- ◆ chlorpyrifos (Lorsban 75 WG) at 2 to 2.67 lb/a. PHI 14 days. REI 24 hr. No more than three applications per season. Trunk sprays or cover sprays (trunk sprays will be less disruptive).
- ◆ Imidacloprid (Admire Pro) at 1.2 to 2.4 oz. Can be applied as soil application through chemigation system, rates and restrictions differ for this application, see label. If applied as drench, allow adequate time for uptake prior to beetle emergence. Generic labels available. **PHI 7 days.** REI 12 hr.

Hazelnut—Scale insect

Includes

Cottony maple scale (*Pulvinaria innumerabilis*)
European fruit lecanium (*Parthenolecanium corni*)
Excrescent scale (*Eulecanium excrescens*)

Pest description and crop damage Mature scale are up to 0.2 inch across, reddish brown, and rounded, resembling small helmets or bumps on branches, stems, and the underside of leaves. Adult cottony maple scale produce copious amounts of white cottony filaments containing eggs in summer. The crawlers are flat, oval, and pinkish brown. Scale are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Severe infestations can kill twigs. Large quantities of honeydew are produced, which causes growth of sooty mold fungus. Sooty mold fungus can impede photosynthesis and severely devitalize plants and retard growth.

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.

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 increases in the populations.

Management—chemical control: HOME USE

Applications are directed at crawlers that appear in June or early July. Take precautions when treating scale to avoid disrupting pollinators that may actively foraging on honeydew.

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI minimum of 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ gamma-cyhalothrin
- ◆ insecticidal soap—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed and have shown efficacy against scale.
- ◆ 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

- ◆ acetamiprid (Assail 70WP) at 0.57 to 1 oz/100 gal water (2.3 to 4.1 oz/a). PHI 14 days. No more than 4 applications per season.
- ◆ imidacloprid (Admire Pro 1.6) at 1.2 to 2.4 fl oz/a. PHI 7 days. REI 12 hr. Generic labels for imidacloprid are available.
- ◆ pyriproxyfen (Esteem 35 WP) at 4-5 oz/100 gal water. Do not apply more than twice per season. PHI 21 day. REI 12 hr.

Hazelnut—Shothole borer

European shothole borer, pear-blight beetle (*Anisandrus dispar*)

Lesser shothole borer, fruit-tree pinhole borer (*Xyleborinus saxesenii*)

Shothole borer (*Scolytus rugulosus*)

Pest description and crop damage This complex of small beetle species share the common name alias “shothole borer” because of the characteristic damage caused by entrance or emergence of adult beetles from the woody host, leaving many small holes resembling a shotgun pattern. Shothole borer (*Scolytus rugulosus*) feeds directly on the wood and each gallery contains many tunnels and emergence holes. The adult female beetle bores into the tree and excavates along the grain of the wood where roughly 50 eggs are deposited along gallery walls. Each larva mines its own tunnel out from the wall of the gallery, feeding perpendicular to the wood grain and replacing the empty space in the tunnel with sawdust excrement (frass). The many larval tunnels fan out from the egg gallery, each one expanding in diameter as the larvae inside mature. The larvae pupate at the ends of the mines leaving the adults to finish the tunnel by chewing their way to the outside. The two other “shothole borer” species recovered from hazelnuts (*Anisandrus dispar* and *Xyleborinus saxesenii*) belong to an ecological guild known as ambrosia beetles. Ambrosia beetles have an obligate association with fungi, which they introduce to their tunnels and cultivate as their only food source. The larvae live together in the galleries feeding on the fungus rather than boring through the wood. The tunnels are maintained by the adult females and all debris generated by the residents is ejected through the entrance hole. The fungi introduced by ambrosia beetles can cause wilting and die-back of branches as the vascular tissue becomes restricted as the fungi colonize the tree. Opportunistic wood decay fungi may be introduced into the wood as a result of attack by any of the borers affecting hazelnuts. The adults can be difficult to identify, but the galleries are easily distinguished. The clean, uniform-size tunnels in the galleries of ambrosia beetles can be easily distinguished from the numerous expanding frass-filled tunnels radiating out from the central egg gallery in *S. rugulosus*.

Shothole borers 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 nut trees. Borers are primarily a problem on injured or stressed plants, but healthy trees growing adjacent to blocks of neglected trees also may be attacked. Hazelnut orchards adjacent to woodlands are also at risk. The adult shothole borer is a brown or black beetle about 0.08 inch long. The larvae are white, legless, and about 0.17 inch long.

Biology and life history Shothole borer larvae overwinter beneath the bark of infested trees where they pupate. Adults emerge in spring or early summer, mate, and fly to susceptible trees to feed at the base of leaves or small twigs. They then tunnel into the tree, excavating galleries parallel to the wood grain where they lay their eggs. 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 March. This activity creates many small, round exit holes that produce a “shothole” effect. There are two generations per year.

Scouting and thresholds Examine branches in late spring for holes 0.08 inch in diameter, oozing sap and sawdust. Beetles are especially attracted to unhealthy trees. Entrance holes often appear as wet stains on hazelnut trunks.

Management—cultural control

The best management tool is keeping trees healthy through proper pruning, adequate watering, and fertilizing. Healthy trees repel

the beetles by plugging galleries with sap and resins. Remove and destroy infested wood on the tree or nearby piles of infested green wood, especially cherry. 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 from shothole borer. Tanglefoot or other sticky substances applied to trunks and branches may trap some beetles. Yellow sticky cards are effective for monitoring flights of adult beetles (March–September). Commercial or homemade lures that release ethanol are also very attractive to adult beetles. Intensive mass trapping of adult beetles in orchards could help reduce damage.

Management—chemical control: HOME USE

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

Management—chemical control: COMMERCIAL USE

There are no chemicals registered for this pest on hazelnut. Registered materials with high residual activity could be used as trunk sprays but are not likely to provide much control.

Hazelnut—Spider mite

Tetranychus spp.

Pest description and crop damage Tiny, eight-legged, non-insect pests that suck juices and devitalize trees. Spider mites tend to occur on the underside of leaves. Webbing accompanies heavy infestations. Leaves become yellow and silver and may more easily sunburn. Spider mites are an increasing problem in hazelnuts. In some cases severe defoliation can occur.

Management—biological control

Rain and cool temperatures tend to suppress mite populations. 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 and released within the orchard.

Management—cultural control

Home orchardists: Mite populations can be physically reduced by spraying the tree with water. Population reductions may allow natural predators to gain control of an outbreak.

Management—chemical control: HOME USE

- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ insecticidal soap—Some formulations are OMRI-listed for organic use.
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against spider mites.
- ◆ pyrethrins (often as a mix with sulfur)—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

- ◆ bifenthrin—
 - Brigade WSB at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
 - Fanfare EC at 3.2 to 12.8 fl oz/a. PHI 7 days. Do not graze livestock on treated cover crops. Highly toxic to bees and toxic to fish and aquatic invertebrates.
- ◆ etoxazole (Zeal) at 0.5 to 0.75 oz/100 gal water (2 to 3 oz/a). PHI 28 days. One application per season.

- ◆ fenpyroximate (Fujimite) at 2 pt/a. PHI 14 days).
- ◆ hexythiazox (Savey 50DF) at 3 to 6 oz/a. PHI 28 days. REI 12 hr. Apply at first sign of egg laying, before adult mites build up (does not control adult mites). Apply only once per season. Do not graze or feed livestock on cover crops growing in treated areas.
- ◆ pyridaben (Nexter) at 2.67 oz/100 gal water (10.67 oz/a). PHI 7 days. Do not exceed two applications per season.
- ◆ spiroticlofen (Envidor 2SC) at 16 to 18 fl oz/a. PHI 7 days. REI 12 hr.

Hazelnut—Tent caterpillar

Includes

Forest 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 polystyrene.

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 defoliate small trees totally, which may not kill them, but it reduces growth and makes the trees more susceptible to diseases. 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 moths mate and females lay eggs that overwinter. There is one generation per year.

Pest monitoring Look for egg masses on twigs or other overwintering sites. 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

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

Management—chemical control: HOME USE

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
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ insecticidal soap—Some formulations OMRI-listed for organic use.
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use and have shown efficacy against tent caterpillars.
- ◆ pyrethrins (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

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Follow label instructions. Add a spreader-sticker to enhance control. Some formulations are OMRI-listed for organic use.

Hazelnut—Winter moth

Operophtera brumata

Pest description and crop damage Four species of inchworm may injure tree fruit or hazelnuts, three of which are native to North America. The fourth, and potentially most serious, is the European winter moth, which was introduced to the PNW in 1958. Adult males are gray or off-white moths which are present in late fall and winter, hence the name. Female moths are wingless. The larvae are pale green with a light stripe down their sides, up to 0.5 inch long. Larvae damage young hazelnut buds and leaves. Symptoms of leaf feeding are distinct from leafroller larvae: leaves are tied together with silken threads but not rolled and leaves appear tattered. In commercial orchards, this insect seldom is a pest.

Biology and life history Wingless females deposit 100 to 200 eggs on hazelnut stems or in crevices in bark 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 Check for larvae from March 15 to May 31, checking three terminals per tree and three leaf clusters per terminal. Each terminal is a sampling unit. Treat when infestation level is 20%.

Management—biological control

General predators such as lacewings, assassin bugs, tachinid flies, and spiders feed on the larvae, although populations are not always well regulated by these predators. Temperature may play a bigger role in controlling populations.

Management—cultural control

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

Management—chemical control: HOME USE

No products registered on this host for this pest.

Management—chemical control: COMMERCIAL USE

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Apply with spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ carbaryl (Sevin XLR Plus) at 2 to 5 quarts/a. Other formulations are also available. PHI 14 days. REI 12 hr. Extremely toxic to aquatic invertebrates.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 75 WG at 2 to 2.67 lb/a. PHI 14 days. REI 24 hr. Do not exceed three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not exceed three applications per season. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 6.5 to 14.2 oz/100 gal (26 to 57 fl oz/a). PHI 14 days. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ chlorpyrifos + O-diethyl-O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate (Vesper, Vulcan) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Do not make more than 3 applications per season.
- ◆ diflubenzuron (Dimilin 2L) at 12 to 16 fl oz/a. PHI 28 days. REI 12 hr. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water.
- ◆ diflubenzuron + lambda-cyhalothrin (DoubleTake) at 4 to 5 fl oz/a. PHI 28 day. REI 24 hr. Do not exceed 20 fl oz/a per growing season or 15 fl oz/a per year growing season post bloom. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water, 150 ft if applied by air.

Walnut Pests

Nik Wiman and Neil Bell

Latest revision—March 2018

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.

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

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

Walnut—Aphid

Includes

Dusky winged aphid (*Callipterus juglandis*)
Walnut aphid (*Chromaphis uglandicola*)

Pest description and crop damage Walnut aphids are pale yellow, much smaller than the dusky-veined aphid, and feed on the lower surface of leaves. Dusky-veined aphids have dark banded spots on their backs and are found feeding along the mid-vein on the top surface of leaves. Both aphids suck plant juice and deposit honeydew. Feeding of the dusky-veined aphid causes the leaf midrib to turn black. The honeydew is toxic to the husk of some varieties and turns it black. High populations may lead to leaf drop and a loss of nut yield and quality. Aphid populations are most damaging in spring and early summer when nuts are developing rapidly.

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

Management—biological control

In the 1980s, a parasitic wasp was introduced (*Trioxys pallidus*) which has reduced problems with the walnut aphid substantially. In addition, aphids have many natural enemies including ladybeetles, syrphid fly larvae, and green lacewings. Avoid broad-spectrum insecticide applications which would disrupt these controls.

Management—cultural control

Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. *Home orchardists:* Avoid excessive watering which, together with nitrogen applications, produces flushes of succulent growth. Control ants, which “farm” the aphids for their honeydew and protect them from predators.

Management—chemical control: HOME USE

Dormant-season spray

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

- ◆ superior-type oil

Growing-season spray

Predators usually reduce aphid populations. Apply pesticides only when predators are few and aphid population is heavy.

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ bifenthrin
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ horticultural oil—Some formulations OMRI-listed for organic use.
- ◆ imidacloprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ insecticidal soap—May require several applications to be effective. Some formulations are OMRI-listed for organic use.
- ◆ kaolin clay (Surround at Home)—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ permethrin
- ◆ plant-derived essential oils (clove, garlic, peppermint, rosemary oil, etc.)—Some formulations are OMRI-listed for organic use and have shown efficacy against aphids.
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Aphids seldom warrant control. Predators usually reduce aphid populations. Pesticide applications are advised only when predators are few and aphid population is heavy.

- ◆ acetamiprid (Assail 30SG) at 0.047 to 0.18 lb ai/a. No more than 4 applications and a maximum of 0.72 lb ai/a per growing season. Retreatment interval 14 days. PHI 14 days.
- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. Retreatment interval 7 days. Maximum 0.075 lb ai/a. PHI 7 days.
- ◆ azadirachtin (Azasol, Azatin, others)—See label for rates. Some formulations are OMRI-listed for organic use. REI 4 hr.
- ◆ *Beauveria bassiana* (Mycotrol O)—See label for rates. OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.19 to 0.022 lb ai/a. Maximum per 14 days and per season: 0.022 lb ai/a. PHI 14 days.
- ◆ bifenthrin (Brigade WSB) at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr.
- ◆ bifenthrin+abamectin B1 (Athena) at 7.5 to 20 fl oz/a. Retreatment interval 21 days. Maximum of 2 applications per season. PHI 21 days.
- ◆ chlorantraniliprole+lambda-cyhalothrin (Voliam Xpress) at 6 to 12.5 fl oz/a (suppression only). PHI 14 days. REI 24 hr. Minimum of 7 days between applications. Do not exceed a total of 31.0 fl oz of Voliam Xpress or 0.24 lb ai of products containing lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole-containing foliar products per acre per growing season.
- ◆ chlorpyrifos+gamma-cyhalothrin (Cobalt) at 26 to 57 fl oz/a. PHI 14 days. Do not make more than 2 applications per season of Cobalt or other product containing chlorpyrifos for walnuts.
- ◆ clothianidin (Belay) at 0.05 to 0.1 lb ai/a. Maximum 0.2 lb ai/a. PHI 21 days.

- ◆ cyantraniliprole (Exirel) at 13.5 to 20.5 oz. Retreatment interval 7 days. PHI 5 days. REI 12 hr.
- ◆ deltamethrin (Delta Gold) at 0.02 lb ai/a. Maximum 0.165 lb ai/a. Retreatment interval 7 days. PHI 21 days.
- ◆ esfenvalerate (Asana XL) at 0.05 to 0.1 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not feed or graze livestock on treated orchard floors. Extremely toxic to fish and aquatic habitat.
- ◆ horticultural oil—Some formulations OMRI-listed for organic use.
- ◆ imidacloprid (Admire Pro) at 7 to 14 oz for soil application or 1.2 to 2.4 oz for foliar application. PHI 7 days. REI 12 hr. Generic formulations of imidacloprid are available.
- ◆ insecticidal soap (M-Pede) at 2% solution. PHI 0 days. Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin (Warrior II) at 0.02 to 0.04 lb ai/a. PHI 14 days. REI 1 day. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
- ◆ malathion (Malathion 57% EC) at 0.2 to 0.4 oz/a. PHI 7 days. REI 12 hr.
- ◆ methidathion (Supracide 25W) at 4 to 12 lb/a. PHI 7 days. REI 2 to 14 days depending on the rate. Apply as a cover spray when aphids appear. Do not tank-mix with oils, which can injure trees. Do not graze.
- ◆ naled (Dibrom 8E) at 4 pints/a. PHI 10 days. REI 48 hr. Do not graze.
- ◆ pyriproxyfen (Esteem 35WP) at 4 to 5 oz /a. PHI 21 days. REI 12 hr. Do not exceed two applications per season.
- ◆ spinosad (Success 2L) at 4 to 10 fl oz/a. PHI 14 days. REI 4 hr. Allow at least 7 days between treatments. Do not exceed 29 fl oz/a per year.
- ◆ spinosad (Entrust SC) at 4 to 10 oz/a. PHI 14 days. REI 4 hr. OMRI-listed for organic use.
- ◆ spirotetramat (Movento) at 6 to 9 fl oz. PHI 7 days.
- ◆ sulfoxaflo (Closer SC) at 1.5 to 2.75 oz. PHI 7 days. REI 12 hr.
- ◆ tolfenpyrad (Bexar) at 17 to 27 oz. PHI 14 days. REI 12 hr.
- ◆ zeta-cypermethrin (Mustang, Mustang Max, Mustang Maxx) at 0.02 to 0.025 lb ai/a. Maximum of 0.125 lb ai/a per season. PHI 21 days.

Walnut—Codling moth

Cydia pomonella

Pest description and crop damage White or pink larvae up to 0.625 inch long may enter and destroy the nut. Feeding within the husk may stain nut shells. The type of injury varies with the time of infestation. Early infestations arrest nut development and may result in heavy nut drop. Codling moth is rarely a problem in walnuts in the Pacific Northwest.

Biology and life history Codling moth overwinters as mature larvae in silken cocoons spun under loose bark, in the soil, or in litter at the base of the tree. Pupation takes place in the early spring, and adults emerge around the time of bloom. Adults are active only at dusk and dawn and lay eggs on leaves or occasionally on fruit. The larvae emerge from the eggs and search out the nuts to begin feeding. Sprays are typically applied to target the eggs and the young larvae before they enter the husk. Larvae may bore to the center of developing nuts to feed on the kernel. As they mature, they push frass out of the entry hole. After 3 to 4 weeks the nut may drop, and the larvae may leave the nut to seek a sheltered spot on the tree to spin cocoons. 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 warm areas, there may even be a third flight of moths. Larvae produced by the late moth flight may penetrate nuts but they often do not complete development before harvest or winter.

Pest monitoring Pheromone traps can be used to monitor populations. They can be used to set damage thresholds and they can also be used to set phenology models. Check with your Extension agent on moth levels in your area. There is a very low threshold for damage, as minor infestations one year can turn into a major problem the next.

Management—biological control

A number of natural enemies have activity against codling moth so conservation biological control is important for maintaining low pest populations. However, insect biological controls have not proven effective in controlling outbreaks of this pest. Sprays of *Bacillus thuringiensis serotype kurstaki* (*Btk*) have not proven effective. Insecticidal granulosis virus (OMRI-listed) is effective against larvae and there are several commercial formulations including Cyd-X. Application of virus should be timed to egg hatch, or approximately 200 to 250 degree days.

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 a lot. A number of hand-applied and aerosol pheromone release devices are available for mating disruption of codling moth. This management tactic can be very successful on large orchard blocks (>10 ac) and moderate to low codling moth populations.

Management—chemical control: HOME USE

Spray timing depends on moth emergence. The first spray is usually when the average nut size is 0.375 to 0.5 inch in diameter.

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ horticultural oil—Some formulations are OMRI-listed for organic use.
- ◆ insecticidal soap—May require several applications to be effective. Some formulations are OMRI-listed for organic use.
- ◆ kaolin clay (Surround at Home)—Applied as a spray to leaves, stems, and fruit, it acts as a repellent to some insect pests. Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ permethrin
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Spray timing depends on moth emergence. The first spray is usually when the average nut size is 0.375 to 0.5 inch in diameter.

- ◆ acetamiprid (Assail 30SG) at 0.1 to 0.18 lb ai/a. No more than 4 applications and a maximum of 0.72 lb ai/a per growing season. Retreatment interval 14 days. PHI 14 days.
- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. Retreatment interval 7 days. Maximum 0.075 lb ai/a. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.016 to 0.019 lb ai/a. Maximum per 14 days and per season 0.022 lb ai/a. PHI 14 days.
- ◆ bifenthrin (Brigade WSB) at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr.
- ◆ bifenthrin + abamectin B1 (Athena) at 7.5 to 20 fl oz/a. Retreatment interval 21 days. Maximum 2 applications per season. PHI 21 days.
- ◆ carbaryl (Sevin XLR Plus) at 2.5 to 5 quarts/a. PHI 14 days. REI 12 hr. Extremely toxic to aquatic invertebrates.
- ◆ chlorantraniliprole (Altacor) at 3 to 4.5 oz. PHI 10 days. REI 4 hr.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 6 to 12.5 fl oz/a (suppression only). PHI 14 days. REI 24 hr. Minimum of 7 days between applications. Do not exceed a total of 31.0 fl oz of Voliam Xpress or 0.24 lb ai of products containing lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole-containing foliar products per acre per growing season.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 4E at 4 pints/a. PHI 14 days. REI 1 day. Do not exceed two applications per season. Do not graze. Extremely toxic to fish. Toxic to birds and wildlife.
 - Lorsban 75WG at 2.6 lb/a. PHI 14 days. REI 1 day. Do not exceed two applications per season. Do not graze. Extremely toxic to fish. Toxic to birds and wildlife.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 26 to 57 fl oz/a. PHI 14 days. Do not make more than 2 applications per season of Cobalt or other product containing chlorpyrifos for walnuts.
- ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 26 to 57 fl oz/a. PHI 14 days. Do not make more than 2 applications per season of Cobalt or other product containing chlorpyrifos for walnuts.
- ◆ cyantraniliprole (Exirel) at 13.5 to 20.5 oz. Retreatment interval 7 days. PHI 5 days. REI 12 hr.
- ◆ cyfluthrin (Tombstone) at 0.031 to 0.038 lb ai/a. Maximum 0.044 lb ai/a per season. PHI 14 days.
- ◆ deltamethrin (Delta Gold) at 0.02 lb ai/a. Maximum 0.165 lb ai/a. Retreatment interval 7 days. PHI 21 days.
- ◆ diflubenzuron (Dimilin 2L) at 16 fl oz/a. Most effective if applied before egg-laying. Extremely toxic to aquatic invertebrates. Do not apply within 25 ft of bodies of water. Do not make more than 4 applications per season. PHI 28 days. REI 12 hr.
- ◆ dodecadien (Checkmate)—Mating disruption. See label for rates. Studies in apple indicate that a minimum of 10 acres is required for successful treatment. OMRI-listed for organic production.
- ◆ esfenvalerate (Asana XL) at 10 to 16 fl oz/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not feed or graze livestock on untreated orchard floors. Extremely toxic to fish and aquatic habitat.
- ◆ flubendiamide (Belt SC) at 0.094 to 0.125 lbs ai/a. Retreatment interval 7 days. Maximum 0.375 lbs ai per season. REI 12 hr. PHI 14 days.
- ◆ lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
- ◆ malathion (Malathion 57% EC) at 0.4 to 0.6 oz/a. PHI 7 days. REI 12 hr.

- ◆ methoxyfenozide (Intrepid 2F) at 0.19 to 0.38 lb ai/a. PHI 14 days. REI 4 hr. The higher rates in the recommended rate range may be required for extended residual effectiveness, high pest infestation levels, larger trees, or heavy dense foliage. Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- ◆ permethrin—
 - Ambush 2E at 16 to 24 oz/a. PHI 1 day. REI 12 hr. Extremely toxic to fish and aquatic habitat.
 - Pounce 3.2 EC at 8 to 16 oz/a. PHI 1 day. REI 12 hr. Extremely toxic to fish and aquatic habitat.
- ◆ pyriproxyfen (Esteem 35WP) at 4 to 5 oz /a. PHI 21 days. REI 12 hr. Do not exceed two applications per season.
- ◆ spinetoram (Delegate WG) at 3 to 7 oz/a. PHI 14 days. Apply no less than one week apart, with a maximum 4 applications per season.
- ◆ spinosad (Entrust SC) at 4 to 10 oz/a. PHI 14 days. REI 4 hr. OMRI-listed for organic use.
- ◆ spinosad (Success) at 4 to 8 fl oz/a. PHI 14 days. REI 4 hr. Do not exceed 29 oz/a per year or apply fewer than 14 days apart.
- ◆ zeta-cypermethrin (Mustang, Mustang Max, Mustang Maxx) at 0.02 to 0.025 lb ai/a. Maximum of 0.125 lb ai/a per season. PHI 21 days.

Walnut—Fall webworm

Hyphantria cunea

Pest description and crop damage Fall webworm is the most common tent-making caterpillar in North America and has a very wide host range that includes more than 100 deciduous trees and shrubs. Nut trees are among the preferred hosts. The adult moth has a wing expanse of 2 inches and is almost pure white with a few black spots. The larvae are variable in appearance, but in general are about 1 inch long and very hairy. Larvae have paired dark spots on each body segment. The larvae vary in color, being yellow or pale green with a black head, or a darker color with reddish-brown hairs and a red head.

Biology and life history The insect overwinters as a light-colored cocoon in protected areas like bark furrows or the sides of buildings. Adult moths emerge in late spring, and lay eggs on the undersides of leaves. The larvae skeletonize leaves and incorporate leaves and twigs into their tent. Full-grown larvae leave the plant and look for a protected place to overwinter. There is usually one generation per year, though in warm areas there may be more.

Management—cultural control

Cut out and destroy any developing tents.

Management—chemical control: HOME USE

- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- ◆ bifenthrin
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ lambda-cyhalothrin
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.

Management—chemical control: COMMERCIAL USE

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. Treat when larvae first appear. Use a spreader-sticker. Some formulations are OMRI-listed for organic use.

Walnut—Scale insect

Includes frosted scale (*Lecanium prunosum*)

Pest description and crop damage The frosted scale is potentially the most serious soft scale pest of walnuts. Mature scales are brownish, convex, and covered with frostlike wax. Fine waxy filaments may protrude from the base of the scale body. These insects suck plant juices, causing loss of vigor and potentially reducing nut yield and quality. They also produce copious amounts of honeydew, which can result in sooty mold buildup. Low to moderate populations may be tolerated, but high populations can be damaging.

Biology and life history The frosted scale overwinters as a nymph on twigs and small branches. In spring it grows rapidly, becomes convex, forms a frostlike waxy cover, and secretes large amounts of honeydew. In late spring females lay many eggs, which fill the entire space beneath their cover, and die after egg production. The white waxy substance weathers away, leaving oval, dark brown covers that may be present for a year or more. Newly hatched nymphs or crawlers emerge from beneath the scale cover in late spring and settle mostly on the underside of leaves. Here they feed for the rest of the summer. In fall, the nymphs molt and move back to twigs.

Management—chemical control: HOME USE

Control has not been necessary in the PNW. Apparently, this pest is held in check by natural factors. If control is needed, 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.

- ◆ superior-type oil

Growing-season spray

- ◆ acetamiprid—Do not apply until after trees have flowered or when bees are actively foraging. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ gamma-cyhalothrin
- ◆ horticultural oil—Some formulations are OMRI-listed for organic use.
- ◆ insecticidal soap—May require several applications to be effective. Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils (clove, garlic, peppermint, rosemary oil, etc.)—Some formulations are OMRI-listed and have shown efficacy against scale.
- ◆ permethrin
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Control has not been necessary in the PNW. Apparently, this pest is held in check by natural factors. If control is needed, use:

- ◆ clothianidin (Belay) at 0.05 to 0.1 lb ai/a. Maximum 0.2 lb ai/a. Retreatment 10 days. PHI 21 days.
- ◆ methidathion (Supracide 25W) at 11 to 12 lb/a. PHI 7 days. REI 2 to 14 days, depending on rate. Do not tank-mix with oils, which can injure trees. Do not graze. Liquid formulations are also available.

- ◆ methoxyfenozide (Intrepid 2F) at 0.12 to 0.25 lb ai/a. PHI 14 days. REI 4 hr. Apply at first sign of larval infestation. Do not exceed 24 fl oz/a per application or 64 fl oz/a (1 lb ai/a) per season. Do not apply within 25 ft of an aquatic habitat, 150 ft if applied by air.
- ◆ pyriproxyfen (Esteem 35WP) at 4 to 5 oz/a. PHI 21 days. REI 12 hr. Do not exceed two applications per season.
- ◆ spirotetramat (Movento) at 6 to 9 fl oz. PHI 7 days.

Walnut—Walnut blister mite

Aceria erineus

Pest description and crop damage Very small eriophyid mite causes blister like swelling on upper leaf surface and yellowish or brown concave pocket on underside of leaf. These insects usually do not cause enough damage to warrant control.

Biology and life history This mite overwinters beneath bud scales. When the weather warms up, the mites feed beneath the leaves amongst the leaf hairs. Several generations occur during the summer, which attack new foliage as soon as it unfurls.

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. Avoid excessive nitrogen applications, as this encourages mites.

Management—chemical control: HOME USE

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

Walnut—Walnut husk fly

Rhagoletis completa

Pest description and crop damage The walnut husk fly is native to the south-central United States, but is now widespread throughout western North America. The walnut husk fly is about the size of a housefly. It has a yellow spot just below the areas where the wings are attached and the wings have three prominent dark bands, one of which extends around the wing to form a V-shape. The maggots are white and up to 0.19 inch long. Larvae feed in groups within the husk, which stains the nutshell, and lowers nut quality. Dark, soft blotches on maturing husks are a good clue to husk fly presence. Blotches that are hard and dry are caused by walnut blight (a disease) and should not be confused with husk fly damage. The walnut husk fly is becoming more of a problem each year based on the numbers of cases reported. In other states, the Franquette and Mayette varieties and seedlings of Manregian and Carpathian are considered very susceptible to husk fly damage.

Biology and life history Walnut husk flies overwinter as pupae in the soil and emerge as adults in early- to mid- summer. Female flies deposit eggs in groups of about 15 below the surface of the husk. The egg deposits show up as small black areas on the husk. Eggs hatch into white maggots within 5 days. The maggots feed inside the husk, enlarging the black area, which remains soft, unbroken, and smooth. The outer skin of the husk usually remains intact, but its fleshy parts decay and stain the nutshell. After feeding on the husk for 3 to 5 weeks, mature maggots drop to the ground and burrow several inches into the soil to pupate. Most emerge as adults the following summer, but some remain in the soil for 2 or more years.

Pest monitoring Use fly traps. Sticky, green, spherical traps look similar to developing nuts and attract the flies. Yellow sticky cards

baited with ammonium carbonate “chargers” are also effective for trapping. These are the same traps useful for other *Rhagoletis* pest species including cherry fruit fly and apple maggot. Place traps high in the upper half of the canopy if possible by late May/early June. Make first treatment within 10 days after catches in fly traps show a sharp or steady increase over a 3 day period, probably early- or mid-August. A degree day phenology model is available from www.uspest.org to predict emergence of adults, oviposition and egg hatch.

Management—biological control

Native parasites and predators do not effectively control this pest.

Management—cultural control

Remove abandoned black walnut or English walnut trees. Flailing of pre- and post harvest nuts can aid in preventing the fly from successfully pupating in the soil.

Management—chemical control: HOME USE

Timely application of sprays is important in order to prevent adult flies from laying eggs (see sampling recommendations, above).

- ◆ acetamiprid—Do not apply when bees are actively foraging or until after trees have flowered. Do not make more than one application a year. PHI 7 days.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ esfenvalerate
- ◆ gamma-cyhalothrin
- ◆ lambda-cyhalothrin
- ◆ permethrin
- ◆ pyrethrins—Some formulations are OMRI-listed and have shown efficacy against scale.
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

Timely application of sprays is important (see sampling recommendations, above). Efficacy of insecticides targeting adult flies can be enhanced by tank mixing commercial fruit fly baits, or use GF-120, a bait/insecticide formulation. Incorporating baits can also reduce the need for precision spray coverage as flies will be attracted to droplets for feeding.

- ◆ acetamiprid (Assail 30SG) at 0.12 to 0.15 lb ai/a. Add a recommended rate of husk fly bait. No more than 4 applications and a maximum of 0.72 lb ai/a per growing season. Retreatment interval 14 days. PHI 14 days.
- ◆ alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/a. Retreatment interval 7 days. Maximum 0.075 lb ai/a. PHI 7 days.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.019 to 0.022 lb ai/a. Maximum of 0.22 lb ai/a per season. PHI 14 days.
- ◆ bifenthrin (Brigade WSB) at 0.1 to 0.2 lb ai/a. PHI 7 days. REI 12 hr.
- ◆ bifenthrin+abamectin B1 (Athena) at 13.5 to 20 fl oz/a. Retreatment interval 21 days. Maximum of 2 applications per season. PHI 21 days.
- ◆ chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 6 to 12.5 fl oz/a (suppression only). PHI 14 days. REI 24 hr. Minimum of 7 days between applications. Do not exceed a total of 31.0 fl oz of Voliam Xpress or 0.24 lb ai of products containing lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole-containing foliar products per acre per growing season.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban 4E at 3 to 4 pints/a. PHI 14 days. REI 1 day. Do not exceed one dormant-stage application or two foliar spray

- applications on walnuts per season. Do not graze orchard floors.
- Lorsban 75WG at 2.67 lb/a. PHI 14 days. REI 1 day. Do not exceed two applications on walnuts per season. Do not graze orchard floors. Extremely toxic to fish. Toxic to birds and wildlife.
 - ◆ chlorpyrifos + gamma-cyhalothrin (Cobalt) at 26 to 57 fl oz/a. PHI 14 days. Do not make more than 2 applications per season of Cobalt or other product containing chlorpyrifos for walnuts.
 - ◆ clothianidin (Belay) at 0.05 to 0.1 lb ai/a. Maximum 0.2 lb ai/a per season. Retreatment 10 days. PHI 21 days.
 - ◆ cyfluthrin (Tombstone) at 0.038 to 0.044 lb ai/a. Maximum 0.044 lb ai/a per season. PHI 14 days.
 - ◆ deltamethrin (Delta Gold) at 0.02 lb ai/a. Maximum 0.165 lb ai/a. Retreatment interval 7 days. PHI 21 days.
 - ◆ esfenvalerate (Asana XL) at 10 to 16 fl oz/a. PHI 21 days. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not feed or graze livestock on treated orchard floors. Extremely toxic to fish and aquatic habitat.
 - ◆ lambda-cyhalothrin (Warrior II) at 1.28 to 2.56 fl oz/a. PHI 14 days. REI 24 hr. Do not exceed 0.16 lb ai/a per season or 0.12 lb ai post bloom.
 - ◆ malathion (Malathion 57% EC) at 0.4 to 0.6 oz/a. PHI 7 days. REI 12 hr.
 - ◆ permethrin—
 - Ambush 25W at 16 to 24 oz/a. PHI 1 day. REI 12 hr. Do not graze livestock in treated orchards. Extremely toxic to fish and aquatic habitat.
 - Ambush 2E at 16 to 24 oz/a. PHI 1 day. REI 12 hr. Do not graze livestock in treated orchards. Extremely toxic to fish and aquatic habitat.
 - Pounce 3.2 EC at 8 to 16 oz/a. PHI 1 day. REI 12 hr. Do not graze livestock in treated orchards. Extremely toxic to fish and aquatic habitat.
 - ◆ phosmet (Imidan 70W) at 4.33 to 8.5 lb product/a. PHI 28 days. REI 7 days. Do not exceed five applications per season. Highly toxic to bees. Extremely toxic to fish. Avoid spray drift and runoff to surface waters.
 - ◆ spinetoram (Delegate WG) at 3 to 7 oz/a. PHI 14 days. Apply no less than one week apart, with a maximum 4 applications per season.
 - ◆ spinosad (Entrust SC) at 4 to 10 oz/a. PHI 14 days. REI 4 hr. OMRI-listed for organic use.
 - ◆ spinosad (Success) at 4 to 8 fl oz/a. PHI 14 days. REI 4 hr. Do not exceed 29 oz/a per year or apply fewer than 14 days apart.
 - ◆ spinosad bait (GF-120 NF) at 20 fl oz/a. PHI 0 days. REI 4 hr. Apply every 7 days. Can be applied from the air or with an all-terrain vehicle (ATV). Apply 0.8 to 1 gal/a with a D3 nozzle attached to an ATV. Apply at 10 to 12 mph, using the listed rate and nozzle size.
 - ◆ zeta-cypermethrin (Mustang, Mustang Max, Mustang Maxx) at 0.02 to 0.025 lb ai/a. Maximum of 0.125 lb ai/a per season. PHI 21 days.

Note: For more information on the husk fly and trapping methods, see OSU Extension publication EM 8907, *Growing Walnuts in Oregon* (<https://catalog.extension.oregonstate.edu>), and WSU Extension publication FS039E, *The Walnut Husk Fly* (<https://pubs.wsu.edu/>).