

Nut Crops

Chestnut Pests

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Latest revision—March 2020

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 mature, larvae are whitish with a translucent, amber-color head, 0.5 inch long. The larvae feed within the nut and destroy the kernel.

Biology and life history Filbertworms 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 overwinter 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 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.
- ◆ 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 with 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 day 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.
- ◆ 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 Advanced at 3–4 pints/100 gal. 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 (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.
- ◆ chlorantraniliprole (Altacor) at 3 to 4.5 oz/a. PHI 10 days. REI 4 hr.
- ◆ *Chromobacterium subsugae* strain PRAA4 (Grandevo) at 1 to 3 lb/a. OMRI-listed for organic production.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6–12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14–21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season.

- ◆ 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.
- ◆ spinosyns—
 - ◆ 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 (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
 - ◆ 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.
 - ◆ 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. Lindgren funnel traps can also be effective. Ethanol baits can enhance trap captures.

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

No commercial products are specifically labeled for this pest, but products registered for chestnut with long residuals may be somewhat effective treatments for trunks and branches during flight periods to deter some borers from entering trees.

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 aphids that feed on leaves and husks and produce honeydew. Filbert aphid is typically more problematic in Willamette Valley hazelnut orchards. It is a green aphid primarily found on undersides of leaves where it feeds on phloem along leaf veins, while hazelnut aphid is primarily found on husks. Filbert aphid is typically green or pale yellow and lacks well-developed cornicles, which are tube-like projections that emerge from the abdomen. Hazelnut aphid by contrast has well-developed cornicles, longer legs, and also may have reddish coloration. Experimental evidence indicates that heavy infestations of aphids should be controlled to prevent reduced fill and smaller nut size. 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. Honeydew produced by aphids is colonized by sooty mold fungus. Sooty mold fungus can impede photosynthesis and severely devalue plants and retard growth.

Biology and life history Aphids overwinter as eggs in crevices in bark and on twigs, and around buds and leaf scales. Eggs turn from a greenish color to black as they mature. In early spring, eggs hatch in synchrony with budbreak, and the aphids feed on swelling buds and leaflets before moving to the leaves. The population can increase rapidly, and there are 8 to 10 generations per year. In the fall, sexual males and females are formed. These mate and females 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 per 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 on treatment and check back on population levels in a week. Mummified aphids indicate that the parasitoid is active. The mummies appear swollen, rounded and darker and may have an exit hole chewed by the wasp. Note that populations of aphids typically peak by June and will decrease substantially by July regardless of management action.

Management—biological control

An introduced parasitoid wasp (*Trioxys pallidus*) targeting this aphid has become well established in the Willamette Valley. This biological control makes aphid sprays unnecessary in many hazelnut orchards. Learn to recognize mummies and avoid treating when biological control is active. The aphid has a lower temperature threshold for development than the wasp, which typically emerges about two weeks after the aphids. As a result, there is typically some lag time between population increase of aphids and the response of the wasp. Pest management that is detrimental to the wasp population can aggravate aphid problems. Note also that broad-spectrum insecticide applications made against other pests can free the aphid from biological control causing its population to surge. There are a number of important predators of aphids that occur in hazelnut orchards including ladybird beetles (larvae and adults), syrphid fly larvae, Geocoris (big-eyed bugs), Deraecoris (plant bugs), and lacewing larvae. Yellowjackets also prey on aphids.

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 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
- ◆ imidacloprid—PHI 7 days.
- ◆ insecticidal soap—Some formulations OMRI-listed for organic use.
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ mineral or vegetable oils—Dormant or delayed dormant applications can kill aphid eggs. Use caution not to interfere with active pollination.
- ◆ 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 1.0 oz/100 gal water (2.3 to 4.1 oz/a). PHI 14 days. REI 12 hr. No more than 4 applications per season.
- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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.
- ◆ clothianidin (Belay) at 3 to 6 oz/100 gal water. Use the low rate for smaller infestations or smaller trees. Apply no more than 0.2 lb a.i./acre per year.
- ◆ 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, Admire Pro, generics) at 3.4 to 7 fl oz/a. PHI 7 days. REI 12 hr. 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/a. PHI 7 days. REI 1 day.
- ◆ sulfoxaflor (Closer SC) at 1.5 to 2.75 oz/a. PHI 7 days.

Hazelnut—Brown Marmorated Stink Bug

Halyomorpha halys

Pest description and crop damage An invasive pest that has been increasingly attacking hazelnuts in the Willamette Valley. There are five immature stages, and all but the first feed on the plant. Early season feeding and reproduction in the orchard can lead to damaging populations that can damage kernels. Nymphs initially feed on vegetative structures such as leaves and husks, but later stages can feed directly on nuts. Shell thickness or hardness does

not protect kernels from feeding damage as the mouthparts of the insect can penetrate the shell allowing it to feed on the kernel within. Depending on when the insect feeds on the nuts, they can cause blanks, 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 any trap captures warrant scouting of the orchard to detect potentially damaging populations. Presence of nymphs in the crop can be an indicator for potential damage. 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 can sometimes build much sooner. The population level at the end of the previous season, winter survival, and weather during spring are all factors affecting current season population levels.

Management—biological control

The samurai wasp, *Trissolcus japonicus*, an adventive parasitoid wasp from Asia was detected in Vancouver, Washington in 2015 and in Portland, Oregon in 2016. This parasitoid is becoming established in the Willamette Valley and researchers are actively redistributing the wasp. This wasp attacks the stink bug egg masses, turning them from bright green or blue to black as the wasps develop in the egg mass and eventually chew their way out of the eggs. The wasp is known to be a highly effective parasitoid against brown marmorated stink bug in Asia. Native parasitoids and predators can also help limit stink bug populations. There are numerous predators (spiders, katydids, lacewing larvae) that attack the eggs and early nymphs. The mature nymphs and adults have fewer natural enemies, but sometimes birds and spiders will target them. Crabronid wasps (*Astata bicolor*) are a specialized predator that sting the nymphs to paralyze them, then carry the paralyzed stink bugs to their nests in the ground where the stink bugs are used to provision the nest for their young. Note that most chemical treatments are broad-spectrum, so treatments may cause flare-ups of secondary pests such as scale and aphids.

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. Home orchardists may also find that exclusion netting is possible. 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.

- ◆ carbaryl
- ◆ esfenvalerate
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ 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.
- ◆ beta-cyfluthrin (Baythroid XL) at 2 to 2.4 oz/a. PHI 14 days. REI 12 hr.
- ◆ 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 -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.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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 water (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.
- ◆ 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 (Provado 1.6) at 3.4 to 7 fl oz/a. PHI 7 days. REI 12 hr. Generic labels for imidacloprid are available.
- ◆ lambda-cyhalothrin—
 - 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.
 - 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.
 - 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.
 - 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.
- ◆ 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.
 - PermaStar AG at 8 to 16 oz/a. PHI 14 days. REI 12 hr. Highly toxic to bees, toxic to fish and aquatic invertebrates.
 - 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.
- ◆ zeta-cypermethrin (Mustang Maxx) at 3.2 to 4 oz/a. PHI 7 days. REI 12 hr.

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 bud break 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). Feeding on buds in early spring can be particularly damaging for small trees

Pest monitoring Look for larvae in nests of webbed-together leaves in the spring. Compare with similar pests such as leafroller and omnivorous leaf-tier.

Management—chemical control: HOME USE

- ◆ *Bacillus thuringiensis* var. *kurstaki*—See label for rates. PHI 0 days. Apply with spreader-sticker. Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins

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.
- ◆ chlorpyrifos—Generic labels for chlorpyrifos are also available.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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 water (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.
- ◆ diflubenzuron (Dimilin 2L) at 8 to 16 oz/a. Up to four applications per season. PHI 28 days. REI 12 hr.
- ◆ flubendiamide (Belt SC) at 3 to 4 oz/a. PHI 14 days. REI 12 hr. Do not exceed 12 oz/a per year or 4 oz per 7 day interval.
- ◆ methoxyfenozide (Intrepid 2F and generics) at 8 to 16 oz/a. PHI 14 days. REI 4 hr.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6 to 12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season.

Hazelnut—Filbert bud mite

Filbert bud mite (*Phytocoptella avellanae*)
Cecidophyopsis vermiformis

Pest description and crop damage Also known as big bud mite, these microscopic eriophyid mites feed on and within leaf and flower buds and catkins. Buds swell to large size (blasted buds) before they die and fall off. Bud mites are a big problem in some legacy hazelnut varieties, especially Ennis, Daviana and Royal. The OSU hazelnut breeding program selects against bud mites so blasted buds are relatively rare in recent cultivar releases. However, severe infestations have been noted in Lewis, Clark, Casina, Yamhill, and McDonald cultivars. 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. Sprays applied at

the peak migration timing will be most successful. Recent research suggests the peak migration typically occurs from late March/early April to mid-May in the Willamette Valley. 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. Most materials labeled for bud mite cannot be applied by air.

Management—biological control

Releases of predatory mites (*Galendromus* spp.) is impractical in commercial settings but may be effective for home use. Predatory mites cohabitate in blasted buds with bud mites. Mite flaring may be linked to use of broad-spectrum insecticides and loss of biological control predatory mites. Note that predatory mites also help keep spider mites under control.

Management—chemical control: HOME USE

No products are registered for home use for this pest.

Management—chemical control: COMMERCIAL USE

- ◆ abamectin (Abamectin 0.15 EC) at 10 to 20 oz/a. PHI 21 days. REI 12 hr. Do not exceed two applications per season.
- ◆ calcium polysulfide (Sulfurix) at 3 gal/a. REI 2 days.
- ◆ fenpyroximate (Fujimite XLO) at 2 to 4 pints/a in minimum of 100 gal water. No more than two applications per season.
- ◆ lime-sulfur (BSP) at 12 gal/a. REI 2 days.
- ◆ micronated sulfur
 - Kumulus DF at 5 to 25 lb/a in 50 to 400 gal water. See 24(c) SLN label. Do not apply when air temperatures will exceed 90°F within 3 days of application. REI 24 hr.
 - Microthiol Disperss at 10 to 20 lb/a in 50 to 400 gal water. See 24(c) SLN label. Do not apply when air temperatures will exceed 90°F within 3 days of application. REI 24 hr.
- ◆ pyridaben (Nexter) at 2.67 oz/100 gal water (10.67 oz/a). PHI 7 days. Do not exceed two applications per season.
- ◆ spirodiclofen (Envidor 2SC) at 16 to 18 fl oz/a. PHI 7 days. REI 12 hr.
- ◆ tolfenpyrad (Bexar) at 27 oz/a. PHI 14 days. REI 12 hr. See 2(ee) label for hazelnut (OR/WA only).

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.

- ◆ 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.
- ◆ *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ 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 applications 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 worms 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.
- ◆ bifenthrin (Brigade WSB, other generics) at 0.05 to 0.2 lb ai/a. PHI 7 days. REI 12 hr.
- ◆ carbaryl (Sevin XLR Plus) 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 Advanced at 3 to 4 pints/100 gal. 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. One application per season. PHI 45 days. REI 18 days. WA and OR only.

- ◆ 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.
- ◆ lambda-cyhalothrin—
 - Warrior II/ 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.
 - LambdaStar/ 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) 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.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6 to 12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season.
- ◆ permethrin—
 - Ambush 25W at 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.
 - 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.
- ◆ spinosyns—
 - 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 (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
 - 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.

Hazelnut—Filbertworm

Cydia latiferreana

Pest description and crop damage Filbertworm is the key pest of hazelnuts in the Pacific Northwest and a close relative of codling moth, one of the most economically important insects worldwide. Adult moths are gray to reddish with golden bands across each forewing. Female moths lay the eggs near nut clusters and larvae must locate the nuts and gain entry. 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, as the larvae gain entry into the kernel through the micropyle on the basal scar, but the much larger exit hole is apparent after the larvae has finished devouring the kernel. Research has shown that shell thickness at the basal scar can affect susceptibility of different hazelnut cultivars.

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 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 in spring 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 as fully developed larvae. Most then form cocoons (hibernacula) to overwinter, although some may pupate and become moths within that season (i.e., multiple generations). Sprays are timed to target the eggs and the wandering early larvae before they penetrate the nuts. Proper timing of spray applications is critical when selecting materials with lower residual and when taking advantage of the ovicidal activity of some materials. Use the degree-day model with a weather station near the orchard or provide your own weather data from the orchard. This tool is available from the Integrated Plant Protection Center (IPPC): <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. Moth captures will not be representative if traps are not placed high in the canopy (pheromone is heavier than air). 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 late crop damage so it is important to keep monitoring through harvest.

Management—biological control

Predators and parasitic wasps likely assist in killing some larvae before they gain entry to the nuts. Some moths may also be killed by predators. Bats may capture moths on the wind during dusk flight periods.

Management—cultural control

Isomate FBW Ring is a commercial mating disruption product. Apply a minimum 20 dispensers per acre. Hang pheromone dispensers high in the canopy on lateral branches before initial moth flight. Continue to monitor traps and prepare to apply border sprays or supplemental cover sprays if traps continue to capture moths at rates above the threshold. Large, contiguous blocks under mating disruption are most effective. The continual release of pheromone from dispensers in the orchard interferes with the male moth's ability to locate females for mating within the orchard. Mated females originating from outside the orchard can still come in and lay eggs resulting in damaged nuts. Mating disruption technology is best applied to low to moderate filbertworm populations, so consider getting any problematic moth populations under control before utilizing mating disruption. Do not apply to home orchards, orchards with steep slopes, or orchards with lots of edge.

First nut drop typically contains a higher percentage of nuts infested by filbertworm. Flailing or otherwise destroying these first nuts prior to harvest may reduce infestation levels. Flailing acorns from oaks near the orchard may also help reduce pressure.

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.

- ◆ azadirachtin (neem oil)—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ lambda-cyhalothrin
- ◆ pyrethrins
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin
- ◆ kaolin clay (suppression)

Management—chemical control: COMMERCIAL USE

Filbertworm emergence notices are sent to growers. These can serve as a rough guide for approximate spray timings. Pheromone trapping and use of the degree-day phenology model should be used to optimize spray timing and efficacy.

- ◆ 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.
- ◆ beta-cyfluthrin (Bathroid) at 2 to 2.4 oz/a. PHI 14 days. REI 12 hr.
- ◆ 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.
- ◆ 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 Advanced at 3 to 4 pints/100 gal. 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. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ flubendiamide + buprofezin (Tourismo) 10 to 14 fl oz/a in a minimum of 100 gal water. Do not apply as alternate row middle (ARM) sprays; full cover sprays only. PHI 60 days. REI 12 hr.

- ◆ lambda-cyhalothrin—
 - Warrior II/ 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.
 - LambdaStar/ 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.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6-12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season.
- ◆ 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 3.2 to 4 oz/100 gal water (13 to 16 oz/a). Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spinosyns—
 - 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 (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
 - 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.
- ◆ kaolin clay (Surround WP) at 50 to 75 lb/a. Suppression only. PHI 0 days. REI 4 hr.
- ◆ 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—Garden symphylan

Scutigera immaculata

Pest description and crop damage Symphylans are not insects but represent a unique class of soil-dwelling arthropod similar in appearance to centipedes. They are white in color and are smaller than centipedes. Immatures have 6 legs, but as symphylans mature they acquire up to 12 pairs of legs and the antennae elongate. There is just one pair of legs per segment which is similar to centipedes but different from millipedes (2 pair per segment). Garden symphylans can damage new orchard plantings if the orchard site has a history of pressure from this pest. Typically this would occur when former grass seed or Christmas tree fields with a history of the pest are converted to hazelnut orchards. The symphylans move to the roots of newly planted hazelnut trees where they cause feeding damage. When a grass crop is sprayed out to plant a hazelnut orchard, the symphylans may aggregate at the roots of the newly planted hazelnut trees because there is no other food source. Tree damage may not be evident for some time after it has occurred,

but trees that have been attacked may become symptomatic during periods of water stress when it becomes apparent that the damaged roots cannot support necessary water uptake. It is unlikely that the symphylans would actually be found during the hotter periods of the growing season as they utilize the soil profile to thermoregulate and typically go deeper when soil surfaces are too warm. The pest tends to aggregate in the upper soil profile in spring and fall when surface soil is moist and temperatures are moderate. Sampling efforts should be concentrated during these periods when the symphylans are in the upper soil strata. If there is a problem the white symphylans should be evident in the roots of establishing trees, so the problem cannot be diagnosed without digging up trees at a time when the symphylans are active. Older trees should be resistant to the pest. Symphylan “hot spots” or patches tend to recur year after year in the same areas of the field or orchard.

See:

Biology and Control of the Garden Symphylan

Pest monitoring Dig young trees when soil is moist and temperatures are moderate in the spring or fall to inspect roots for symphylans. Soil samples can be used to collect symphylans and taking cores can help estimate activity at different depths. Baits can also be used to attract symphylans for detection and monitoring. Cut a carrot or potato in half and bury it in a shallow hole carefully dug so as to not disturb the below soil structure, then cover it. After 2-5 days recover the bait to examine for presence of symphylans.

Management—cultural control

Sample for symphylans before planting the orchard, particularly if the orchard site was formerly producing grass seed or Christmas trees. Manipulation of soil structure is a management tactic. Tillage in particular can crush symphylans that are at the soil surface and may disrupt the soil porosity that the symphylans rely upon to move through the soil profile. Symphylans cannot tunnel through the soil, so they need the naturally occurring pores to move through the soil. Slight soil compaction through rolling may also help reduce soil pore connectivity and symphylan presence in the upper soil profile.

Management—chemical control: HOME USE

This pest is unlikely to be an issue for home orchards.

Management—chemical control: COMMERCIAL USE

Pesticides or fumigants are more effective when applied prior to planting. Depending on the crop that was there prior to planting, more chemical pest management options may be available.

While there are chemistries that are registered for hazelnut that can be somewhat effective against garden symphylans, none are specifically labeled for garden symphylan.

Hazelnut—Obliquebanded leafroller

Choristoneura rosaceana

Pest description and crop damage Bright green caterpillar with a black or brown head. They 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, and if they are applied against mature larvae, they will likely harm natural enemy populations. 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.

- ◆ 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.
- ◆ *Bacillus thuringiensis* var. *kurstaki*—Some formulations are OMRI-listed for organic use.
- ◆ *Beauveria bassiana*—Some formulations are OMRI-listed for organic use.
- ◆ carbaryl
- ◆ esfenvalerate
- ◆ kaolin—Some formulations are OMRI-listed for organic use.
- ◆ lambda-cyhalothrin
- ◆ plant-derived essential oils—Some formulations are OMRI-listed for organic use.
- ◆ pyrethrins (often as a mix with other ingredients)—Some formulations are OMRI-listed for organic use.
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

- ◆ 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.

- ◆ 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.
- ◆ carbaryl (Sevin XLR Plus) 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 Advanced at 3 to 4 pints/100 gal. 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. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ 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.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6-12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season
- ◆ 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 3.2 to 4 oz/100 gal water (13 to 16 oz/a). Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spinosyns—
 - 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 (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
 - 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.

Hazelnut—Omnivorous leaftier

Cnephasia longana

Pest description and crop damage European in origin, this pest has been present in Oregon since 1929. 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 can be a serious problem in young hazelnut orchards. Feeding on buds and early terminals can set back tree growth and can cause poor tree structure.

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. Compare with similar pests such as leafroller and eyespotted budmoth.

Management—chemical control: HOME USE

- ◆ carbaryl

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 qt/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.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ 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.

- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6 to 12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season

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 female is considerably larger than the male. 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 begin to emerge from wood in late May or early June and continue emerging into August. They 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 when larvae 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.

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 by drilling the ovipositor through the

bark to lay the egg on the flatheaded borer larvae. Carpenter ants eat both larvae and pupae from the wood. Generalist predatory mites can enter galleries and feed on overwintering larvae and pupae.

Management-cultural control

Young, recently planted trees are most susceptible. Trees that are stressed because of drought or other causes are especially vulnerable. Irrigate new plantings. Minimize drought stress on young trees with irrigation. Avoid planting in very dry soils. Control weeds and avoid intercrop competition for moisture. These borers 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. Painting trunks with white latex paint will prevent sunburn.

Management—chemical control: HOME USE

- ◆ zeta-cypermethrin—Applied as trunk spray may have some efficacy.

Management—chemical control: COMMERCIAL USE

Approaches to management include treatment with systemic insecticides or applying residue barrier sprays to trunks.

- ◆ chlorpyrifos (Lorsban Advanced) at 3 to 4 pints/a. PHI 14 days. REI 24 hr. Use no more than 8 pints per acre per season. Extremely toxic to fish. Toxic to birds and wildlife. 2(ee) recommendation for OR only.
- ◆ clothianidin (Belay) at 3 to 6 oz/100 gal water. Use the low rate for smaller infestations or smaller trees. Apply no more than 0.2 lb ai/a per year. PHI 21 day. REI 12 hr. 2(ee) recommendation for OR only.
- ◆ imidacloprid (Admire Pro) at 1.4 to 2.4 oz/a. Generic labels available. Can be applied as soil application through chemigation system, rates and restrictions differ for this application, see label. PHI 7 days. REI 12 hr. Not specifically labeled for Pacific flatheaded borer but applications for aphid control will help control this pest.

Hazelnut—Scale insect

Includes

Cottony scale (*Pulvinaria spp.*)
European fruit lecanium (*Parthenolecanium corni*)
Excrecent 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 female cottony scale produce copious amounts of white cottony filaments containing eggs in summer. The crawlers are flat, oval, and pinkish brown. Chemical management should target the crawler stage. Scale insects are closely related to aphids, mealybugs, and whiteflies. Like these insects, they also have piercing-sucking mouthparts. Severe infestations can kill twigs and may have reduced nut size and kernel fill similar to aphids. 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-biological control

Parasitoids attack scale and scale outbreaks may be the result of broad-spectrum insecticide use. Monitor biological control by scouting for small emergence holes on the mature females where the parasitoid has chewed its way out of the scale host.

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.
- ◆ bifenthrin
- ◆ carbaryl
- ◆ 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.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

- ◆ acetamiprid (Assail 70WP) at 0.57 to 1.0 oz/100 gal water (2.3 to 4.1 oz/a). PHI 14 days. REI 12 hr. No more than 4 applications per season.
- ◆ buprofezin (Centaur WDG) at 34.5 to 46.0 oz/a. No more than one application per season. PHI 60 day. REI 12 hr.
- ◆ clothianidin (Belay) at 3 to 6 oz/100 gal water. Use the low rate for smaller infestations or smaller trees. Apply no more than 0.2 lb ai / year. PHI 21 day. REI 12 hr.
- ◆ imidacloprid (Admire Pro) at 1.4 to 2.4 oz/a. Generic labels available. PHI 7 days. **REI 12 hr.**
- ◆ pyriproxyfen (Esteem 35 WP) at 3.2 to 4 oz/100 gal water (13 to 16 oz/a). Do not apply more than twice per season. PHI 21 day. REI 12 hr.
- ◆ spirotetramat (Movento) at 6 to 9 oz/a. Minimum reapplication interval is 14 days. PHI 7 day. REI 24 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 Any of this complex of small beetle species from the beetle subfamily Scolytinae are sometimes referred to as “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. The holes that these species leave in their hosts are always small and round in contrast with the flattened D-shaped exit holes left by Pacific flatheaded borer.

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, particularly trees where roots may be suffering from lack of oxygen because soil is saturated with water. 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 during periods of beetle flight.

Hazelnut—Spider mite

Tetranychus spp.

Pest description and crop damage Tiny, eight-legged, non-insect pests that suck juices and devitalize trees. Webbing accompanies heavy infestations. Undersides of leaves become yellow and silver where the mite colonies form, and later the entire leaf may bronze. Spider mites are common late in the growing season, and they sometimes reach populations that are high enough to cause major defoliation of the orchard. This problem is likely to increase with climate change if growing seasons continue to get hotter.

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. This approach is much more feasible for home orchardists and small acreage hazelnut growers.

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.
- ◆ bifenthrin
- ◆ 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.
- ◆ 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. REI 12 hr.
- ◆ hexythiazox (Savey 50DF) at 3 to 6 oz/a. PHI 28 days. REI 12 hr. Does not significantly control adult rust mites. Apply at first sign of egg laying, before adult mites build up. 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 (Envirdor 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 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
- ◆ 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 The European winter moth 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, possibly because management for other pests also control winter moth. Baited traps will catch moths but damage is rare at this time.

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%. Commercial lures and traps are available and moths can be caught in high numbers. However, damage is not very common and apparently not highly correlated with the number of moths that are caught in traps.

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

- ◆ 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 Advanced at 3 to 4 pints/100 gal. 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. Do not make more than 3 applications per season of Cobalt or other product containing chlorpyrifos for hazelnuts.
- ◆ 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 2020

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 (*Trioxys pallidus*) was introduced,

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 when parasitoids are active against aphids.

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 and on the increase.

- ◆ 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
- ◆ 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.
- ◆ sulfur
- ◆ sulfur/oil/pyrethrins (Natria insect, disease and mite control)
- ◆ 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 ESO)—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 day 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.
- ◆ 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 to 0.033 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.
- ◆ 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.
- ◆ sulfoxaflor (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 A gray tortricid moth with coppery spots on the wings and white or pink larvae up to 0.625 inch long that can damage walnuts. While codling moth is an important pest of walnuts in California, it is rarely a problem on walnuts grown in the Pacific Northwest. The type of injury varies with the time of infestation. Early season infestations arrest nut development and may result in heavy nut drop. Later in the season, feeding within the husk may stain nut shells but does not affect kernels, or larvae may enter the shell and destroy the kernel.

Biology and life history Codling moth overwinters as mature larvae in silken cocoons (hybernacula) spun under loose bark, in the soil, or in litter at the base of the tree. Pupation takes place in the 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* var. *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 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
- ◆ 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.
- ◆ beta-cyfluthrin (Baythroid XL) at 0.016 to 0.019 lb ai/a. Maximum per 14 day 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.
- ◆ 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.
- ◆ chlorpyrifos— Generic labels for chlorpyrifos are also available.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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 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.
- ◆ 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.
- ◆ 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/a 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.
- ◆ methoxyfenozide + spinetoram (Intrepid Edge) at 6-12 oz/a. Apply at initiation of egg hatch, if necessary reapply after 14-21 days, but not before 14 days. PHI 7 days. REI 4 hr. No more than 12 fl oz/a/season.
- ◆ 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.

- ◆ spinosyns—
 - 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 (Entrust SC) at 4 to 10 oz/a. PHI 1 days. REI 4 hr. OMRI-listed for organic use.
 - 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.
- ◆ 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. Mature 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
- ◆ 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 pruinosum*)

European fruit lecanium scale (*Parthenolecanium corni*)

Pest description and crop damage The frosted scale is the most serious soft scale pest of walnuts. Mature scales are brownish, convex, and covered with frost-like wax. Fine waxy filaments may protrude from the base of the scale body. European fruit lecanium scale is similar to frosted scale but lacks the frosty wax coating. 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. Treatments typically target the crawler stage.

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—biological control

Parasitoid wasps typically keep populations under control and they attack all life stages. Avoid broad spectrum insecticides that may impact scale natural enemies and flare populations. Monitor parasitoid activity and time treatments to avoid interfering with them. Look for small emergence holes from nymphs and mature females and uncharacteristically dark nymphs that indicate that wasps are developing inside.

Management—cultural control

On small trees it may be possible to prune off some of the scale colonies. Control ants if they are abundant.

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
- ◆ 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 rarely 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 erinea

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 the most important pest of walnuts in the Pacific Northwest. This pest 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 larvae/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 symptoms of infestation. Blotches that are hard and dry are caused by walnut blight (a disease) and should not be confused with husk fly damage. In California, the Franquette and Mayette varieties and seedlings of Manregian and Carpathian are considered very susceptible to husk fly damage. The damage is largely cosmetic staining on the nutshell and is primarily a concern for in-shell walnuts. Because eggs and maggots are protected in the husk, the adult stage is typically the target for management.

Biology and life history Walnut husk flies overwinter as pupae in the soil and adults emerge 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, unsunken, 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 Traps are very effective and useful for timing management activity. 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 phenology model is available from uspest.org to predict emergence of adults, oviposition and egg hatch based on degree-day accumulation.

Management—biological control

Native parasites and predators do not effectively control this pest.

Management—cultural control

Sanitation is important. Remove nuts from the orchard floor to help prevent the fly from successfully pupating in the soil. Flail, mow or rake nuts that drop early and after harvest. Remove abandoned black walnut or English walnut trees. Ground barriers may help home orchardists. Plastic tarps or heavy mulch layers in place during nut drop can prevent or inhibit larvae from entering the soil to pupate. Some pupae can remain in soil for more than one season so persistent sanitation is key to long term management.

Management—chemical control: HOME USE

Home orchardists may choose not to control the walnut husk fly and tolerate staining of shells. Loosen affected husks by packing nuts with a moist material for several days before hulling. Timely application of sprays is important in order to prevent adult flies from laying eggs (see sampling recommendations, above). Baits mixed with insecticides can reduce the need for good spray coverage for homeowners that don't have capacity to spray the canopy.

- ◆ 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.
- ◆ esfenvalerate
- ◆ lambda-cyhalothrin
- ◆ permethrin
- ◆ pyrethrins—Some formulations are OMRI-listed for organic use.
- ◆ spinosad—Some formulations are OMRI-listed for organic use.
- ◆ zeta-cypermethrin

Management—chemical control: COMMERCIAL USE

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 thorough 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 lambda-cyhalothrin containing products or 0.2 lb ai of chlorantraniliprole containing foliar products per acre per growing season.
- ◆ chlorpyrifos— Generic labels for chlorpyrifos are also available.
 - Lorsban Advanced at 3 to 4 pints/100 gal. 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 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.
- ◆ spinosyns—
 - 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.
 - 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/>).