Agronomic Crops

Farm-Stored Grain Pests

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Latest revision—March 2024

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.

Stored grain pests

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

Storing grain properly

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

Aerate grain

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

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

Inspect grain

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

Prevention

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

Protection

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

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

Management—chemical control

Direct grain treatments

- *Bacillus thuringiensis kurstaki* (Biobit HP) at 0.5 lb. in 5-to-10-gal water per 500 sq ft of grain surface area, mix into top 4 inches for Indian meal moth, Angoumois grain moth, and almond moth. Mix with grain when placed in storage and/or periodically apply to the surface of stored grain; see labels. Biobit HP is OMRI-listed for organic use.
- deltamethrin/piperonyl butoxide (Centynal Synergized Insecticide)—For stored grain use 5 gal of dilution per 1,000 bushels to achieve a 0.5 ppm on the commodity.
- deltamethrin/piperonyl butoxide/s-methoprene (Gravista Insecticide)—Apply solution at the rate of 3 to 5 gal of dilution per 1,000 bushels to achieve a 0.5 ppm concentration of deltamethrin and 1.2 ppm of S-methoprene on the commodity. See the label for specific grain commodity recommendations.
- deltamethrin/s-methprene (Diacon IGR Plus)—Apply at the rate of 3 to 5 gal of dilution per 1,000 bushels. See the label for specific grain commodity recommendations.
- imidacloprid (Dyna-Shield Imidacloprid) at 1.0 fl. oz per 100 lb. of seed.
- malathion (Fyfanon 57% and Malathion 57%)—Mix 8 pints per 25-gal water. Apply 3 gal per 1,000 sq ft.
- piperonyl butoxide/pyrethrins (Stryker Insecticide Concentrate)—For surface treatment dilute 1 part Stryker with 19 parts water and apply at the rate of 1 to 2 gal per 1,000 sq ft. For grain protectant dilute at the rate of 1-part concentrate to 29 parts water. Apply 4 to 5 gal per 1,000 bu. of grain.
- pirimiphos-methyl (Actellic 5E Insecticide) at 5 lb ai/gal. For top dressing treatment apply 3 fl. oz in 2-gal water per 1,000 square feet of grain surface. **Washington only.**
- pyrethrins (Evergreen Pyrethrin)—Dilute 1 part product with 14 parts water and apply at the rate of 2 gal per 1,000 sq ft of grain to a depth of 4 inches.
- s-methoprene (Diacon IGR) at 2.5 lb. ai/gal. Apply 21 fl. oz per ton of grain.
- spinosad (Sensat) at 0.73 lb. ai/gal. For crops typically treated per ton (2,000 lb.) apply 0.35 fl. oz or 10.4 ml per ton to deliver 1 ppm of active ingredient. For top dressing treatments: for each 1,000 sq ft of surface, mix 2.6 fl. oz of Sensat in 2-gal water.

Storage building—residual spray or space treatment

- beta-cyfluthrin (Tempo SC Ultra) at 0.034 to 0.067 oz ai (8 to 16 ml)/1,000 sq ft aa s surface spray for stainless steel units. No international level of tolerance has been established for cyfluthrin. Grain treated with this product may not be accepted in international markets. Avoid contaminating storage areas where exported grains may be stored.
- bifenthrin (Bisect L)—Apply using a 0.02 to 0.06% dilution. Apply as a coarse, low-pressure spray to areas where these pests hide, i.e., cracks and crevasses.
- ddvp (Max Kill Vapocide, Nuvan Aerosol)—Apply as fog or as a ULV coarse spray at a rate of 1 to 2 grams of dichlorvos (0.5 to 1 fl. oz) per 1,000 cu ft. Do not make applications when temperatures are below 60°F.
- deltamethrin (Suspend SC) at 0.08 to 0.5 lb. ai per 100-gal final spray in grain bins and warehouses. Apply to surfaces at 1 gal per 1,000 sq ft. Before storing or handling grain, apply finished spray to equipment, wall and floor surfaces of grain bins and warehouses at the rate of 1 gal per 1,000 sq ft.
- lambda-cyhalothrin (Lamdastar Ultracap) at 0.2 to 0.4 fl. oz per gal water (0.015 to 0.03% ai). All outdoor applications must be limited to spot or crack-and-crevice treatments only.
- malathion (Loveland Malathion 57EC) at 0.6 lb. ai in 3-gal water and apply on 1,000 sq ft to grain storage facilities. Do not apply to grain.
- piperonyl butoxide/pyrethrins (Stryker Insecticide Concentrate)—For surface treatment dilute 1 part Stryker with 19 parts water and apply at the rate of 1 to 2 gal per 1,000 sq ft.
- pyrethrins/synergist (Py-75, Pyrocide 100, TurboCide Gold) as a contact spray per 1,000 sq ft and followed as a space spray per 1,000 cu ft. Rates vary; check the label.
- pyriproxyfen-nylar (Turbocide Advanced Fogging Products IGR)—Apply as a space spray at a rate of 0.335 oz (9.5 grams) per 1,000 cu ft of room space.
- tetradecadienyl acetate (Cidetrak IMM)—Apply 1 dispenser per 14,124 to 42,376 cu ft. Apply maximum rate to heavily infested buildings. Do not exceed 200 grams ai per 7,063 cu ft per year.
- s-methoprene (Diacon IGR) may be used as a fogging concentrate. Methoprene does not kill adult insects but rather prevents reproduction.

Fumigation

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

Grain fumigants

- aluminum phosphide (PH3 Alp Fumigant Tablets and others)—The tablet or pellet formulations are most suitable for farm applications; consult label for directions.
  - Solid aluminum phosphide formulations release hydrogen phosphide (phosphine) gas when exposed to moisture and heat. Warm, humid air accelerates the reaction while cool, dry air slows it down. The reaction starts slowly, gradually accelerates, and then tapers off.
  - Aluminum phosphide tablets and pellets may be applied to the grain mass by probing them below the grain surface, adding them as the grain is turned, or placing them in the aeration ducts below the grain mass. Treatment while turning the grain generally is not feasible in on-farm storage, and often alternative methods must be used to treat the grain in place.
  - In shallow bins, tablets may be probed into the grain using a 5- to 7-foot-long hollow tube, designed for this purpose. These tubes can be purchased or made from electrical conduit or plastic pipe, according to distributor recommendations.
  - Sealing the bin is the single most important step in fumigation. Properly sealing grain bins before fumigation is essential for reaching and maintaining the required combination of gas concentration and exposure time necessary to kill grain pests.
  - Phosphine gas is also available in a pressurized container; consult the label for directions.
  - magnesium phosphide (*Degesch Fumi-Cell*)—Similar to aluminum phosphide, though the more rapid release of phosphine may hinder penetration as well as endanger the applicator. This product must have a Fumigation Management Plan (FMP) in place before use. Consult the label for directions.
  - methyl bromide (Methyl Bromide 100 Commodity Fumigant and others)—Do not use this product when the temperature is below 40°F. This product converts into a gas at temperatures above 39°F and has virtually no odor or irritating qualities to indicate its presence. Consult the label for necessary PPE and work time restrictions when using this product.
  - sulfuryl fluoride (ProFume) applied by trained staff for seeds of any commodities.

Field and Silage Corn Pests

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Latest revision—March 2024

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Field and silage corn—Aphid

Includes
Bird-cherry oat aphid (*Rhopalosiphum padi*)
Corn leaf aphid (*Rhopalosiphum maidis*)

Pest description and crop damage Orange green to olive green and black aphids suck sap. They may become very abundant, especially later in the season. Heavy populations may be evident if golden yellow streaking is found on the leaves. Large populations of aphids may reduce kernel number and size.

Management—chemical control

- abamectin/azoxystrobin/fludioxonil/mefenoxam/thiabendazole/thiamethoxam (Avicta Complete 250 Nematicide/Insecticide/Fungicide) Group 4A 6 insecticide, Group 1,4,11,12 fungicide—Only to be treated directly to seed, in Syngenta-certified facilities, Farmer application not permitted.
- abamectin/thiamethoxam (Avicta Duo 250 Corn) Group 4A 6 nematicide/insecticide—Apply as slurry to corn seed. Only to be treated in Syngenta-certified facilities, Farmer application not permitted.
- alpha-cypermethrin (Fastac CS, Fastac EC) Group 3A insecticide at 0.018 to 0.025 lb ai/A (2.7 to 3.8 fl oz). REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Aza-Direct, Azaguard and several formulations) Biological insecticide/nematicide at 0.02 to 0.35 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana GHA* (Bioceres WP, Mycotrol ESO, BotaniGard, several variations of each) mycoinsecticide at 4 oz/A. REI 4 hr. PHI 0 day. OMRI-listed for organic use.
- bifenthrin (Brigade 2EC) Group 3A insecticide at 0.033 to 0.1 lb ai/A. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season.
- bifenthrin/chlorantraniliprole (Elevest) at 0.084 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28.
- bifenthrin/zeta-cypermethrin (Hero EW insecticide, Hero insecticide, Steed insecticide) at 0.04 to 0.1 lb ai/A. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.. Group 3A insecticide.
- *Burkholderia* spp. strain A396 (Venerate XC) 1 to 4 quarts/A. For suppression only. REI 4 hr. PHI 0 days. Bioinsecticide. OMRI listed.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 5 to 10 fl oz ai/A (suppression only). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days (2 to 3 lb/A). REI 4 hr. OMRI-listed for organic use.
- clothianidin (Lumisure, Nipsit Inside, Poncho 600 Seed Treatment) at 0.044 to 0.88 lb ai per 100 lb of seed. Seed treated with Lumisure must be colored with EPA approved dye. All seed require minimum depth of 0.5 inch. Do not plant non-listed crops in same area less than 4 months after planting treated seed. Group 4A
- deltamethrin (Delta gold 1.5EC) at 0.018 to 0.022 lb ai/A. Suppression only. Do not apply more than 0.095 lb ai/A per growing season. REI 12 hr, PHI 21 days. Group 3
- dimethoate (Dimethoate 400 EC, Drexel Dimethoate 4EC) Group 1B insecticide/miticide at 0.33 to 0.5 lb ai/A (0.6 to 1.0 pint/A). PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Do not apply during pollen shed if bees are foraging actively.
- esfenvalerate (Asana XL, S-Fenvalostar, Zyrate) at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A). For optimum results, direct the spray at the aphid

population so as to achieve maximum coverage of the exposed insects. Aphids not contacted by the spray, such as in whorls and leaf axils, may not be adequately controlled. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season. Group 3 insecticide.

- flupyradifurone (Sivanto 200SL) Group 4D insecticide at 0.09 to 0.14 lb ai/A (7.0 to 14.0 fl oz/A). PHI 7 days forage; 21 days grain, stover or straw. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per calendar year.
- gamma-cyhalothrin (Declare) at 0.01 to 0.15 lb ai/A. For suppression only. PHI 21 days. REI 24 hr. Do not apply more than 0.24 lb ai/A from planting to foliar applications per year.
- malathion (Drexel 5EC, Fyfanon 57EC, Fyfanon 8 lb Emulsion and several other formulations) Group 1 insecticide at 0.6 to 1 lb ai/A (1 pint/A). Limit 2 treatments per year. Retreatment interval 7 days. PHI 7 days. REI 72 hr for detasseling, 12 hr for other activities.
- methomyl (Lannate SP) Group 1A insecticide at 0.23 to 0.45 lb ai/A. PHI 21 days for ears, 3 days for forage, or 21 days for fodder. REI 2 days. Initial application when corn is at 1-2 leaf stage for early control with second application 5 to 7 days later if needed. Do not exceed 2.25 lb ai/A or 5 treatments per season. Retreatment interval 5 to 7 days.
- sulfoxaflor (Transform WG) Group 4C insecticide at 0.023 to 0.047 lb ai/A. PHI 14 days for grain or straw. Do not apply more than 0.09 lb ai of sulfoxaflor per acre per year.
- tebuconazole/lambda-cyhalothrin (Crossover) Group 3 fungicide/insecticide at 0.14 to 0.16 lb ai/A (8 to 9.5 oz/A). PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin per season.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.034 to 0.05 lb ai/A. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Retreatment interval 3 days.

Field and silage corn—Armyworm

Includes
Armyworm (*Pseudaletia unipuncta*)
Beet armyworm (*Spodoptera exigua*)

Pest description and crop damage Outbreaks are more severe in cooler, wet conditions. Armyworm larvae are most threatening from August through October. Mature larvae are 1.5 inches long. Color varies from brown (armyworm) to green. Moths occasionally are attracted to weeds in corn fields.

Management—chemical control

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

- alpha-cypermethrin (Fastac CS and Fastac EC) Group 3A insecticide at 0.02 to 0.025 lb ai/A. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Aza-Direct, Azaguard and several formulations) Biological insecticide/nematicide at 0.02 to 0.35 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Bacillus amyloliquefaciens* D747 TGAI/bifenthrin (Ethos 3D, Ethos XB) at 0.04 to 0.2 lb bifenthrin ai/A. Do not exceed 0.3 lb bifenthrin on field corn per season. REI 12 hr. PHI Group 3A insecticide, Group 44 fungicide.
- *Bacillus thuringiensis* (Javelin WG) biological insecticide at 0.5 to 1.5 lb/A. PHI 0 days. Use according to individual manufacturer's label instructions. OMRI-listed for organic use.
- beta cyfluthrin (Baythroid XL) Group 3 insecticide at 0.013 to 0.022 lb ai/A (1.6 to 2.8 fl oz/A). PHI 0 days for green forage, and 21 days for grain or fodder. REI 12 hr. Do not exceed four applications or 0.175 lb ai/A per season.
- bifenthrin Group 3A insecticide/miticide -
    - Brigade 2EC at 0.033 to 0.1 lb ai/A foliar, 0.04 lb ai/A preemergence, or 0.047 to 0.062 lb ai/A preplant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season. Do not apply Capture LFR as foliar treatment.
    - Sniper LFR at 0.04 to 0.16 lb ai/A. Apply as T band over open furrow or in-furrow with seed. Do not apply more than 0.2 lb ai/A at plant. Field corn—Do not exceed 0.3 lb bifenthrin/A/season including pre-plant.
    - Capture LFR at 0.04 to 0.2 lb ai/A (3.4 to 17.0 fl oz/A).
- bifenthrin/chlorantraniliprole (Elevest) at 0.098 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28.
- bifenthrin/zeta-cypermethrin (Hero EW) Group 3A insecticide at 0.04 to 0.1 lb ai/A foliar or at planting (4.5 to 11.2 fl oz/A). See label for row spacing or per linear feet. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.1 lb ai/A at-plant application, or 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.
- *Burkholderia* spp. (Venerate XC) bioinsecticide at 1 to 4 quarts/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) insecticide at 1 to 2 lb ai/A. PHI 14 days for forage or silage grazing, and 48 days for grain harvest. REI 24 hr. Do not exceed four applications or 8 lb ai/A per season. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 0.052 to 0.08 lb ai/A (6.0 to 10.0 fl oz/A). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days. Use higher listed rates within listed range for large larvae.
- chlorantraniliprole (Coragen) Group 28 insecticide at 0.045 to 0.098 lb ai/A. PHI 14 days. REI 4 hr. Do not exceed 4 treatments or 0.2 lb ai/A per season. Retreatment interval 7 days.
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.3 to 0.9 lb ai/A per 100 gal (1.0 to 3.0 lb product /A). PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) insecticide—Apply to 1st and 2nd instar only at 0.025 to 0.044 lb ai/A (1.6 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/A per season.

- deltamethrin (Delta Gold) Group 3 insecticide at 0.018 to 0.022 lb ai/A (1.5 to 1.9 fl oz/A). PHI 21 days for grain or fodder, and 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/A per season. Retreatment interval 21 days. Limit 5 treatments per year.
- esfenvalerate (Asana XL) Group 3 insecticide at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A). PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season.
- gamma cyhalothrin (Declare) Group 3 insecticide at 0.01 to 0.015 lb ai/A. Effective on first and second instar larvae only. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.8 lb ai/A. PHI 0 day. REI 4 hr. Do not exceed 2 lb ai/A per year.
- indoxacarb (Steward EC) Group 22 insecticide at 0.059 to 0.11 lb ai/A. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.02 to 0.03 lb ai/A. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A per season, 0.06 lb ai/A after silk initiation, or 0.03 lb ai/A after milk stage.
- methomyl (Lannate SP) Group 1A insecticide at 0.22 to 0.45 lb ai/A. PHI 21 days for ears, 3 days for forage, 21 days for fodder. REI 48 hr. Do not exceed 2.25 lb ai/A or 5 treatments per season. Retreatment interval 5 to 7 days.
- methoxyfenozide (Intrepid 2F) Group 18 insecticide at 0.06 to 0.25 lb ai/A. PHI 21 days. Do not exceed 1 lb ai/A per season. REI 4 hr.
- methoxyfenozide/spinetoram (Intrepid Edge) Group 5 and 18 insecticide at 0.094 to 0.281 lb ai/A. PHI 28 days. REI 4 hr. Do not exceed 0.625 lb ai methoxyfenozide and 0.125 lb ai spinetoram per acre per year. Limit 3 treatments. Retreatment interval 4 days except 2 days for silking.
- permethrin— Group 3 insecticides -
  - Ambush 25W at 0.1 to 0.2 lb ai/A foliar or as preemergent. PHI 0 days for forage; 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/A per season.
  - Loveland Permethrin Cutworm Bait at 0.1 to 0.15 lb ai/A. REI 12 hr. PHI 0 days for forage; 30 days for grain harvest or fodder. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
  - Pounce 1.5G at 0.0075 to 0.015 lb ai/1,000 row ft soil or 0.1 to 0.15 lb ai/A broadcast. PHI 0 days for forage; 30 days for grain harvest or fodder (stover). REI 12 hr. Apply in furrow or as band at planting. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- spinetoram (Radiant SC) Group 5 insecticide at 0.023 to 0.047 lb ai/A. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/A per year. Do not exceed 3 treatments. Retreatment interval 4 days.
- spinosad (Success) Group 5 insecticide at 0.023 to 0.094 lb ai/A. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/A per season.
- tebuconazole/lambda-cyhalothrin (Crossover) Group 3 fungicide/insecticide at 0.14 to 0.16 lb ai/A. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin per season.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.04 to 0.05 lb ai/A. PHI 7 days for grain, stover and forage. Apply no more than 0.2 lb ai/A per season. Retreatment interval 3 days.

Field and silage corn—Corn earworm

Helicoverpa zea

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

Management—chemical control

- alpha-cypermethrin (Fastac CS) Group 3A insecticide at 0.011 to 0.025 lb ai/A. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- *Bacillus amyloliquefaciens* D747 TGAI/bifenthrin (Ethos 3D, Ethos XB) at 0.04 to 0.2 lb bifenthrin ai/A. Do not exceed 0.3 lb bifenthrin on field corn per season. REI 12 hr. PHI Group 3A insecticide, Group 44 fungicide.
- beta cyfluthrin (Baythroid XL) Group 3 insecticide at 0.013 to 0.022 lb ai/A (1.6 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Maximum 2.8 fl oz/A in 7-day interval. Do not exceed four applications or 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC, Sniper) Group 3A insecticide at 0.033 to 0.1 lb ai/A (2.1 to 6.4 fl oz/A). PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season.
- bifenthrin/chlorantraniliprole (Elevest) at 0.098 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28. Apply ELEVEST insect control when silking begins and repeat as necessary to maintain control. To control western bean cutworm, apply at egg hatch before they move into the ear.
- bifenthrin/zeta-cypermethrin (Hero) Group 3A insecticide at 0.04 to 0.1 lb ai/A (4.5 to 11.2 fl oz/A). PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.1 lb ai/A at-plant application or 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.
- *Burkholderia* spp. (Venerate XC) bioinsecticide at 1 to 4 quarts/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- carbaryl (Sevin 4F) insecticide at 1 to 2 lb ai/A. PHI 14 days for forage or silage grazing, and 48 days for grain harvest. REI 24 hr. Do not exceed four applications or 8 lb ai/A per season. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 0.045 to 0.08 lb ai/A (5 to 10.0 fl oz/A). For control before larva bores into plant stalk or ear. PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- chlorantraniliprole (Coragen) Group 28 insecticide at 0.045 to 0.098 lb ai/A. PHI 14 days. REI 4 hr. Do not exceed 4 treatments nor 0.2 lb ai/A per season. Retreatment interval 7 days.

- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.6 to 0.9 lb ai/A per 100 gal (2.0 to 3.0 lb product /A). PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) insecticide at 0.025 to 0.044 lb ai/A (1.6 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/A per season.
- deltamethrin (Delta Gold) Group 3 insecticide at 0.018 to 0.022 lb ai/A (1.5 to 1.9 fl oz/A). PHI 21 days for grain or fodder, or 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/A per season. 5 lb ai/A. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season.
- esfenvalerate (Asana XL) Group 3 insecticide at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A). PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season.
- gamma cyhalothrin (Declare) Group 3 insecticide at 0.0075 to 0.0125 lb ai/A. Effective prior to larvae entering the ear only. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- HZNPV (Gemstar LC)—Insecticidal virus product (biopesticide). OMRI-listed for organic use.
- indoxacarb (Steward EC) Group 22 insecticide at 0.059 to 0.11 lb ai/A. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.015 to 0.025 lb ai/A. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A per season, 0.06 lb ai/A after silk initiation, or 0.03 lb ai/A after milk stage.
- malathion (Drexel 5EC, Fyfanon 57EC, Fyfanon 8 lb Emulsion and several other formulations)—See label for rates. Rates may vary between formulations. PHI 7 days. REI 72 hr for detasseling, 12 hr for other activities. Group 1.
- methomyl (Lannate SP) Group 1A insecticide at 0.22 to 0.45 lb ai/A. PHI 21 days for ears, 3 days for forage, 21 days for fodder. Do not exceed 2.25 lb ai/A or 5 treatments per season. REI 48 hr. Retreatment interval 5 to 7 days.
- methoxyfenozide/spinetoram (Intrepid Edge) Group 5 and 18 insecticide at 0.188 to 0.281 lb ai/A. PHI 28 days. REI 4 hr. Do not exceed 0.625 lb ai methoxyfenozide and 0.125 lb ai spinetoram per acre per year. Limit 3 treatments. Retreatment interval 4 days except 2 days for silking.
- permethrin (Ambush 25W) at 0.1 to 0.2 lb ai/A. PHI 0 days for forage; 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between treatments. Do not apply more than 0.6 lb ai/A per season.
- spinetoram (Radiant SC) Group 5 insecticide at 0.023 to 0.047 lb ai/A. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/A per year. Do not exceed 3 treatments. Retreatment interval 4 days.
- spinosad (Success) Group 5 insecticide at 0.047 to 0.094 lb ai/A. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/A per season. OMRI-listed for organic use.
- tebuconazole/lambda-cyhalothrin (Crossover) Group 3 fungicide/insecticide at 0.14 to 0.16 lb ai/A. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin per season.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.022 to 0.05 lb ai/A. PHI 7 days for grain, stover and forage. Do not exceed 0.2 lb ai/A per season. REI 12 hr. Retreatment interval 3 days.

Field and silage corn—Corn rootworm beetle

Diabrotica spp.

Pest description and crop damage Also known as Western corn rootworm. West of the Cascades *D. undecimpunctata* is most common; east of the Cascades *D. virgifera* is common. Both overwinter in egg stage in the soil. Mature larvae are 0.5 inch long, pale yellow, with a brown head and dorsal anal plate. Larvae feed on and mine into corn roots causing stunting and lodging of plants and stand reduction. After feeding for several weeks, larvae pupate in the soil. Adult emergence varies based on temperature and humidity. Adult rootworm females need to feed for a few weeks prior to egg laying in the top 8 inches of soil.

Management—cultural control

Crop rotation helps to reduce infestations from *D. virgifera* as eggs overwinter in soil. The adults of *D. undecimpunctata* overwinter, therefore crop rotation is not as important in managing this species. Early planting is also useful as it allows for greater root development before infestation can impact plant growth.

Management—chemical control

Seed treatments

- abamectin/thiamethoxam (Avicta Duo Corn)—Requires tank mix. Apply as slurry to corn seed. Consult label.
- *Bacillus thuringiensis (Bt)* (Smartstax Pro Enlist). Must be used in conjunction with *Bt* corn. 5% refuge area not containing corn with *Bt* technology is required.
- clothianidin (Lumisure, Nipsit Inside, Poncho 600 Seed Treatment) at 0.044 to 0.88 lb ai per 100 lb of seed. Seed treated with Lumisure must be colored with EPA approved dye. All seed require minimum depth of 0.5 in. Do not plant non-listed crops in same area less than 4 months after planting treated seed. Group 4A
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.05 to 0.1 lb ai/A per 1,000 row feet (1.0 to 3.0 lb product /A). PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- imidacloprid (Attendant 600 FS, Dyna-Shield Imidacloprid 5, Gaucho 480 Flowable and others) Seed treatment at 0.312 to 0.391 lb ai/ 50 lb of seed. (REI 12 hr unless soil-injected or soil-incorporated allows workers to enter the area treated area if no contact with anything treated. Group 4.
- thiamethoxam (Cruiser 5FS) at 1.25mg ai/kernel.

Larvae treatments

- azadirachtin (Aza-Direct, Azaguard and several formulations) biological insecticide/nematicide at 0.02 to 0.35 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Bacillus amyloliquefaciens* D747 TGAI/bifenthrin (Ethos 3D, Ethos XB) at 0.04 to 0.2 lb bifenthrin ai/A. Do not exceed 0.3 lb bifenthrin on field corn per season. REI 12 hr. PHI Group 3A insecticide, Group 44 fungicide.
- bifenthrin (Fanfare EC, Sniper LFR, Capture, and several others)—See label for specific rates. Multiple formulations with varying rates. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/A foliar and at planting plus foliar application per season.
- bifenthrin/chlorethoxyfos Group 1B insecticide applied as T-band over the row or in furrow at time of planting.
    - SmartChoice 5G application rate of 3.0 to 3.5 oz/100 ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. Apply with Smartbox system. Do not exceed one application per year.
    - SmartChoice HC application rate at 1.15 to 1.67 oz/1,000 row ft. See spacing charts in label for actual application rates per A. REI 2 days or 3 days where annual rainfall is less than 25 inches. Apply with Smartbox system. Do not exceed one application per year.
- chlorethoxyfos/bifenthrin (SmartChoice 5G, SmartChoice HC) Group 1B insecticide—SmartChoice HC granular application rate at 1.5 to 1.67 oz ai/1,000 row ft; SmartChoice 5G 4.5 to 5.0 oz/100 ft of row with 30-inch row spacing in field and seed corn. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in-furrow. Apply with Smartbox system. Do not exceed one application per year.
- ethoprop (Mocap 15G) nematicide/insecticide at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- gamma-cyhalothrin (Declare) Group 3 insecticide at 0.0025 lb ai/1,000 row ft at planting. REI 24 hr. Do not exceed 0.045 lb ai/Acre at plant and 0.06 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.005 lb ai/1,000 row ft (planting). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai/A from at plant and foliar applications.
- phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft at plant or cultivation, broadcast or banded but not in-furrow. PHI 30 days to cutting or forage. REI 48 hr. Use only once per season.
- tefluthrin (Force 3G) Group 3 insecticide at 0.0075 to 0.094 lb ai/1,000 row ft. REI 0 hr. T-band or in-furrow at planting. Do not exceed 0.327 lb ai/A per year. Use only once per season.
- terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. Do not exceed 1.3 lb ai/A per season. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. May be side-dressed at cultivation time if preplant treatment was not made. To be effective, apply before corn is 12 inches high.

Adult treatments

- alpha-cypermethrin (Fastac CS, Fastac EC) Group 3A insecticide at 0.017 to 0.025 lb ai/A. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- beta cyfluthrin (Baythroid XL) Group 3 insecticide at 0.013 to 0.022 lb ai/A (1.6 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Maximum 2.8 fl oz/A in 7-day interval. Do not exceed four applications or 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC) Group 3A insecticide at 0.033 to 0.1 lb ai/A (2.1 to 6.4 fl oz/A). PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season. Rootworm adults only.
- bifenthrin/chlorantraniliprole (Elevest) at 0.084 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28.
- bifenthrin/zeta-cypermethrin (Hero, Steed) Group 3A insecticide at 0.04 to 0.1 lb ai/A (4.5 to 11.2 fl oz/A). Only for use on corn rootworm adults. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.1 lb ai/A at-plant application, or 0. 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.
- carbaryl (Sevin 4F) insecticide at 1 to 2 lb ai/A. PHI 14 days for forage or silage, 48 days for grain or fodder. REI 24 hr. Do not exceed four applications or 8 lb ai/A per season. Re-treat every 14 days. Latex-based formulations, such as Sevin XLR Plus, are less hazardous to bees.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 0.052 to 0.08 lb ai/A (6.0 to 10.0 fl oz/A). PHI 21 days. REI 24 hr. As part of an aerial applied corn rootworm control program, use minimum of 9.0 fl oz/A. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.6 to 0.9 lb ai/A per 100 gal. PHI 0 days (2.0 to 3.0 lb product /A). REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) insecticide at 0.025 to 0.044 lb ai/A (1.6 to 2.8 oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/A per season.
- deltamethrin (Delta Gold) Group 3 insecticide at 0.018 to 0.022 lb ai/A (1.5 to 1.9 fl oz/A). PHI 21 days for grain or fodder, or 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/A per season. Retreatment interval 21 days. Limit 5 treatments per year.
- dimethoate (Dimethoate 400 EC) Group 1B insecticide/miticide at 0.33 to 0.5 lb ai/A (0.6 to 1 pint/A). PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Do not apply if bees are foraging actively.
- esfenvalerate (Asana XL) Group 3 insecticide at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A). PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season.
- GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.8 lb ai/A. PHI 0 days. REI 4 hr. Do not exceed 2 lb ai/A per year.
- indoxacarb (Steward EC) Group 22 insecticide at 0.059 to 0.11 lb ai/A. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.02 to 0.03 lb ai/A. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A per season, 0.06 lb ai/A after silk initiation, or 0.03 lb ai/A after milk stage.

- malathion (Gowan Malathion 8, Fyfanon 8 lb Emulsion and other formulations) at 0.6 to 1 lb ai/A. PHI 5 days for Gowan. REI 12 hr. Limit 2 treatments per year. Retreatment interval 7 days. PHI 7 days. REI 72 hr for detasseling, 12 hr for other activities for Fyfanon 8 lb Emulsion. Group 1.
- methomyl (Lannate SP) Group 1A insecticide at 0.22 to 0.45 lb ai/A. PHI 21 days for ears, 3 days for forage, and 21 days for fodder. REI 48 hr. Do not exceed 2.25 lb ai/A or 5 treatments per season. Retreatment interval 5 to 7 days.
- permethrin (Ambush 25W) wettable powder insecticide at 0.1 to 0.2 lb ai/A. PHI 0 days for forage, 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/A per season.
- tebuconazole/lambda-cyhalothrin (Crossover) Group 3 fungicide/insecticide at 0.14 to 0.16 lb ai/A. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin per season.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.034 to 0.05 lb ai/A. PHI 7 days for grain, stover and forage. Do not exceed 0.2 lb ai/A per season. REI 12 hr. Retreatment interval 3 days.

Field and silage corn—Cutworm

Includes
Black cutworm (*Agrotis ipsilon*)
Western bean cutworm (*Loxagrotis albicosta*)

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

Management—chemical control

- alpha-cypermethrin (Fastac CS, Fastac EC) Group 3A insecticide at 0.008 to 0.018 lb ai/A or 0.001 lb ai/1,000 row ft as in furrow, band or T-band. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.
- azadirachtin (Neemix 4.5)—PHI 0 days. REI 12 hr. See label for rates. Slow acting. Apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- *Bacillus amyloliquefaciens* D747 TGAI/bifenthrin (Ethos 3D, Ethos XB) at 0.04 to 0.2 lb bifenthrin ai/A. do not exceed 0.3 lb bifenthrin on field corn per season. REI 12 hr. PHI Group 3A insecticide, Group 44 fungicide.
- beta cyfluthrin (Baythroid XL) Group 3 insecticide at 0.007 to 0.013 lb ai/A (0.8 to 1.6 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Maximum 2.8 fl oz/A in 7-day interval. Do not exceed four applications or 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC, Sniper, Capture LFR) Group 3A insecticide at 0.033 to 0.1 lb ai/A foliar, 0.0023 to 0.0046 lb ai/1,000 row ft at plant, 0.047 to 0.062 lb ai/A preplant incorporated, or 0.04 lb ai/A preemergence. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.1 lb ai/A as an at-plant application. Apply Brigade 2EC in a minimum of 3 gal finished spray per acre. Do not apply Capture LFR as foliar treatment.
- bifenthrin/chlorantraniliprole (Elevest) at 0.084 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28.
- bifenthrin/chlorethoxyfos Group 1B insecticide
    - SmartChoice 5G application rate of 3.0 to 3.5 oz/100 ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
    - SmartChoice HC application rate at 1.15 to 1.67 oz/1,000 row ft. See spacing charts in label for actual application rates per A. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- bifenthrin/zeta-cypermethrin (Hero, Hero EW) Group 3A insecticide at 0.04 to 0.10 lb ai/A (4.5 to 11.2 fl oz/A) see label for specifics on lb per linear ft based on row spacing. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year..
- carbaryl (Sevin 4F, Sevin 5 Bait)—Apply bait or spray at 2 lb ai/A. PHI 14 days for harvest or grazing forage or silage, and 48 days for grain or fodder harvest. REI 24 hr. Do not exceed four applications per season. Early season applications when plants are 6 to 12 inches high should be directed to the lower stalk portions and soil around the plant bases. Do not use if bees are foraging actively in the field.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 0.045 to 0.098 lb ai/A (6.0 to 10.0 fl oz/A). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai/A of chlorantraniliprole per growing season. Retreatment interval 7 days.
- chlorethoxyfos/bifenthrin (SmartChoice 5G, Smartchoice HC) Group 1B insecticide—Apply SmartChoice 5G at 4.5 to 5.0 oz per 1,000 row ft; Smartchoice HC application rate of 1.0 to 1.67 oz / 100 ft row. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in-furrow. Apply with Smartbox system. Do not exceed one application per year.
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.6 to 0.9 lb ai/A per 100 gal (2.0 to 3.0 lb product /A). PHI 0 days (2 to 3 lb/A). REI 4 hr. OMRI-listed for organic use.
- cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/A of cyantraniliprole products per year.
- cyfluthrin (Tombstone) insecticide at 0.013 to 0.025 lb ai/A (0.8 to 1.6 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/A per season.
- deltamethrin (Delta Gold) Group 3 insecticide at 0.012 to 0.018 lb ai/A (1.0 to 1.5 fl oz/A). PHI 21 days for grain or fodder or 12 days for forage or grazing. REI 12 hr. Re-treatment interval is 21 days. Do not exceed 0.095 lb ai/A per season. Retreatment interval 21 days. Limit 5 treatments per year.
- esfenvalerate (Asana XL) Group 3 insecticide at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A), foliar or 0.0023 lb per 1,000 row ft at plant. PHI 21 days. REI 12 hr.
- ethoprop (Mocap 15G) nematicide/insecticide at 3.0 lb ai/A broadcast three days before planting to planting time. REI 48 hr or 72 hr where annual rain is less than 25 inches. One application per season. Mix with the top two inches of soil.

- gamma-cyhalothrin (Declare) Group 3 insecticide at 0.0025 lb ai/1,000 row ft at plant; 0.0075 to 0.0125 lb ai/A foliar application. PHI 1 day for grazing and forage, or 21 days for fodder or silage. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.015 to 0.025 lb ai/A foliar or 0.005 lb ai/1,000 row ft at planting. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A at plant and foliar applications per season, 0.06 lb ai/A after silk initiation, or 0.03 lb ai/A after milk stage.
- methomyl (Lannate SP) Group 1A insecticide at 0.45 lb ai/A. PHI 21 days for ears, 3 days for forage, 21 days for fodder. Do not exceed 2.25 lb ai/A or 5 treatments per season. Retreatment interval 5 to 7 days.
- methoxyfenozide (Intrepid 2F) Group 18 insecticide at 0.06 to 0.25 lb ai/A. PHI 21 days. REI 4 hr. Do not exceed 1 lb ai/A per season. Western bean cutworm only.
- methoxyfenozide/spinetoram (Intrepid Edge) at 0.188 to 0.281 lb ai/A. Specific to western bean cutworm. PHI 28 days. REI 4 hr. Do not exceed 0.625 lb ai methoxyfenozide and 0.125 lb ai spinetoram per acre per year. Limit 3 treatments. Retreatment interval 4 days except 2 days for silking. Group 5 and 18 insecticide.
- permethrin—Group 3 insecticides:
  - Ambush 25W at 0.1 to 0.2 lb ai/A foliar or as preemergent. PHI 0 days for forage harvest or 30 days for grain harvest or fodder. REI 12 hr. Allow 6 days between applications. Do not apply more than 0.6 lb ai/A per season.
  - Loveland Permethrin Cutworm Bait at 0.1 to 0.15 lb ai/A. REI 12 hr. PHI 0 days for forage; 30 days for grain harvest or fodder. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
  - Pounce 1.5G at 0.0075 to 0.015 lb ai/1,000 row ft soil or 0.1 to 0.15 lb ai/A broadcast. Apply in furrow or as band at planting. PHI 0 days for forage harvest or 30 days for grain harvest or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per season.
- spinetoram (Radiant SC) Group 5 insecticide at 0.023 to 0.047 lb ai/A. PHI 3 days forage or fodder; 28 days grain. REI 4 hr. Do not exceed 0.125 lb ai/A per year. Do not exceed 3 treatments. Retreatment interval 4 days. Western bean cutworm only.
- spinosad (Success) Group 5 insecticide at 0.047 to 0.094 lb ai/A. PHI 28 days grain or fodder; 7 days forage. REI 4 hr. Do not exceed 0.188 lb ai/A per season. OMRI-listed for organic use. Western bean cutworm only.
- tebuconazole/lambda-cyhalothrin (Crossover) Group 3 fungicide/insecticide at 0.14 to 0.16 lb ai/A. PHI 21 days fodder and silage. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.48 lb ai/A tebuconazole or 0.12 lb ai/A lambda-cyhalothrin per season.
- tefluthrin (Force 3G) Group 3 insecticide at 0.0056 to 0.075 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0 days.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.016 to 0.035 lb ai/A foliar. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/A per season.

Seed treatments

- clothianidin (Poncho)—Commercial treaters only. See label instructions.
- clothianidin/*Bacillus firmus* (Poncho Votivo) at 0.5 mg ai/seed. Do not exceed 0.5 mg ai/seed.
- thiamethoxam/Abamectin/Azoxystrobin (Avicta Complete). Refer to label instructions.

Field and silage corn—Garden symphylan

Scutigerella immaculata

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

Management—chemical control

- bifenthrin/chlorethoxyfos Group 1B insecticide
  - SmartChoice 5G at 3.0 to 3.5 oz/100 ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
  - SmartChoice HC at 1.15 to 1.67 oz/1,000 row ft. See spacing charts in label for actual application rates per A. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- ethoprop (Mocap 15G) nematicide/insecticide at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Do not exceed 1.3 lb ai/A per season. Band or furrow at planting. Refer to label for aquatic advisory.

See also:

Biology and Control of Garden Symphylan

Field and silage corn—Grasshopper

Several species

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

Management—chemical control

- alpha-cypermethrin (Fastac CS, Fastac EC) Group 3A insecticide at 0.017 to 0.025 lb ai/A. REI 12 hr. PHI 30 days grain and stover; 60 days forage. Retreatment interval 3 days. Do not exceed 0.075 lb ai/A per season.

- azadirachtin (Neemix 4.5)—PHI 0 days. REI 12 hr. See label for rates. Slow acting. Apply early. Thorough coverage and repeat applications are necessary. Some formulations are OMRI-listed for organic use.
- beta cyfluthrin (Baythroid XL) Group 3 insecticide at 0.017 to 0.022 lb ai/A (2.1 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Maximum 2.8 fl oz/A in 7-day interval. Do not exceed four applications or 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC) Group 3A insecticide at 0.033 to 0.1 lb ai/A (2.1 to 6.4 fl oz/A). PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season.
- bifenthrin/chlorantraniliprole (Elevest) at 0.084 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28. With foliar sprays, performance is improved with the addition of a Methylated Seed Oil (MSO) adjuvant at 1 gal per 100 gal of spray volume (1% v/v). Apply when grasshopper populations reach local established thresholds to prevent crop damage. Correct timing of spray applications to nymphal stages and thorough coverage is critical to achieve optimum control. Applications should be made when eggs have hatched and the majority of the grasshopper population is 2nd – 3rd instar nymphs. Once grasshoppers contact and/or ingest ELEVEST insect control there will be rapid feeding cessation. Do not make more than two sequential applications of ELEVEST insect control before rotating to another registered insecticide having a different mode of action.
- bifenthrin/zeta-cypermethrin (Hero, Hero EW) Group 3A insecticide at 0.025 to 0.06 lb ai/A. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. Do not exceed 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.
- carbaryl (Sevin 5 Bait) at 2 lb ai/A. PHI 14 days for forage or silage or 48 days for grain or fodder. REI 24 hr. Do not exceed four applications per season. Retreatments every 14 days.
- chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/A. PHI 14 days. REI 4 hr. Do not exceed 4 treatments nor 0.2 lb ai/A per season. Retreatment interval 7 days.
- chlorantraniliprole/lambda-cyhalothrin (Besiege) Group 3 & 28 insecticide at 0.52 to 0.08 lb ai/A (6.0 to 10.0 fl oz/A). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai of lambda-cyhalothrin or 0.2 lb ai of chlorantraniliprole per acre per growing season. Retreatment interval 7 days.
- cyfluthrin (Tombstone) insecticide at 0.033 to 0.044 lb ai/A (2.1 to 2.8). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Retreatment interval 7 days. Do not exceed four applications or 0.175 lb ai/A per season.
- deltamethrin (Delta Gold) Group 3 insecticide at 0.012 to 0.018 lb ai/A (1.0 to 1.5 fl/A). PHI 21 days for grain or fodder or 12 days for forage or grazing. REI 12 hr. Retreatment interval is 21 days. Do not exceed 0.095 lb ai/A per season. Limit 5 treatments per year.
- dimethoate (Dimethoate 400 EC) Group 1B insecticide/miticide at 0.5 lb ai/A (1 pint/A). PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/A per season.
- esfenvalerate (Asana XL) Group 3 insecticide at 0.03 to 0.05 lb ai/A (5.8 to 9.6 fl oz/A). For control of first and second instar a rate range of 0.02 to 0.03 lb ai/A (3.9 to 5.8 fl oz/A). PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/A per season.
- gamma-cyhalothrin (Declare) Group 3 insecticide at 0.01 to 0.015 lb ai/A. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- indoxacarb (Steward EC) Group 22 insecticide at 0.059 to 0.11 lb ai/A. PHI 14 days grain, 1 day forage, fodder, silage. REI 12 hr. Limit 2 treatments. Do not exceed 0.22 lb ai/A per year.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.02 to 0.03 lb ai/A. PHI 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A per season, 0.06 lb ai/A after silk initiation, or 0.03 lb ai/A after milk stage.
- malathion (Drexel 5EC, Fyfanon 57EC, Fyfanon 8 lb Emulsion and several other formulations)—See label for rates. Rates may vary between formulations. PHI 7 days. REI 72 hr for detasseling, 12 hr for other activities. Group 1.
- zeta-cypermethrin (Mustang) Group 3A insecticide at 0.034 to 0.05 lb ai/A. PHI 7 days for grain, stover and forage. REI 12 hr. Do not exceed 0.2 lb ai/A per season. Retreatment interval 3 days.

Field and silage corn—Mite

Tetranychus spp.

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

Management—chemical control

- bifenthrin (Brigade 2EC) Group 3A insecticide/miticide at 0.08 to 0.1 lb ai/A (5.12 to 6.4 fl oz/A). PHI 30 days for grain harvest, grazing, or cutting for feed. REI 12 hr. Do not apply more than 0.3 lb ai/A per season.
- bifenthrin/chlorantraniliprole (Elevest) at 0.134 to 0.167 lb ai/A. REI 12 hr. PHI 30 days. No more than three applications per year. Do not apply more than a total of 0.2 lb ai/A of chlorantraniliprole and 0.3 lb ai/A of bifenthrin per year. Group 3A and 28. Coverage is essential for control of this pest. Under heavy outbreak conditions, tank mixing with another product that is labeled for this pest is recommended for control. Pyrethroid resistance is common for mites.
- bifenthrin/zeta-cypermethrin (Hero, Hero EW) Group 3A insecticide at 0.1 lb ai/A. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year..
- *Burkholderia* spp. (Venerate XC) bioinsecticide at 2 to 4 quarts/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) bioinsecticide at 0.6 to 0.9 lb ai/A per 100 gal (2 to 3 lb ai/A). PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- dimethoate (Dimethoate 400 EC) Group 1B insecticide/miticide at 0.33 to 0.5 lb ai/A (0.6 to 1.0 pint/A). PHI 14 days forage; 28 days grain. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Do not use during pollen shed.
- etoxazole (Zeal SC) at 0.045 to 0.135 lb ai/A. PHI 21 days. REI 12 hr. Retreatment interval 14 days. Limit 2 treatments per year. Do not ex-

ceed 0.27 lb ai/A per season.

- hexythiazox (Onager) at 0.078 to 0.188 lb ai/A. PHI 30 days. REI 12 hr. One treatment per year.
- phorate (Thimet 20G) at 0.056 to 0.075 lb ai/1,000 row ft, broadcast or banded but not in-furrow. PHI 30 days graze or forage. REI 48 hr. Limit 1 application per season.
- propargite (Comite) at 1.64 to 2.46 lb ai/A. PHI 30 days. REI 13 days. Apply when corn leaves are dry. Use a minimum of 5 gallons spray solution per acre. One treatment per year.
- propyleneglycol monolaurate (Acaritouch) at 12 to 25 oz/100 gal of formulated product. PHI 1 day. REI 4 hr.
- spiromesifen (Oberon 2SC) at 0.09 to 0.25 lb ai/A. PHI 5 days for green forage and silage; 30 days for grain or stover. REI 12 hr. Apply with a minimum of 10 gallons by ground or 5 gallons by air. Limit 2 treatments per year. Do not exceed 0.27 lb ai/A per season. See label for chemigation.
- sulfur at 6 to 15 lb ai/A for spider mite suppression. REI 24 hr.

Field and silage corn—Seedcorn maggot

Delia platura

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

Management—chemical control

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

- beta-cyfluthrin (Baythroid XL) Group 3 insecticide at 0.12 to 0.16 oz ai/1,000 row ft (2.0 to 2.8 fl oz/A). PHI 0 days for forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC, Sniper, Capture LFR) Group 3A insecticide/miticide at 0.0023 to 0.0046 lb ai/1,000 row ft over open seed furrow (0.15 to 0.30 fl oz/ 1,000 linear ft row); 0.047 to 0.062 lb ai/A pre-plant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not exceed 0.1 lb ai/A per season as an at-plant application. Do not apply Capture LFR as foliar treatment.
- bifenthrin/indole-3-butyric acid (Empower2) Granular insecticide at 0.002 to 0.006 lb ai/1,000 row ft in furrow. PHI 30 days. REI 24 hr. Do not exceed 0.3 lb ai/A foliar and at planting.bifenthrin/chlorethoxyfos Group 1B insecticide
    - SmartChoice 5G at 3.0 to 3.5 oz/100 ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
    - SmartChoice HC at 1.15 to 1.67 oz/1,000 row ft. See spacing charts in label for actual application rates per acre. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- chlorethoxyfos/bifenthrin (SmartChoice 5G, SmartChoice HC)—SmartChoice 5G application at 3.0 to 3.5 oz 1,000 row ft; SmartChoice HC application rate of 1.0 to 1.67 oz /100 ft of row. Row spacing rates according to chart in label. REI 2 days, or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/A of cyantraniliprole products per year.
- cyfluthrin (Tombstone) insecticide at 2.0 to 2.8 fl oz/A based on 30-inch row spacing (0.12 to 0.16 fl oz/1,000 row ft). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.175 lb ai/A per season.
- gamma-cyhalothrin (Declare) Group 3 insecticide at 0.0025 lb ai/1,000 row ft at planting. REI 12 hr. Do not exceed 0.06 lb ai/A from at-plant and foliar treatments.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.005 lb/1,000 row ft. 21 days. REI 24 hr. Do not apply more than 0.12 lb ai/A per season at plant or foliar applications.
- permethrin (Loveland Permethrin) Group 3 insecticide at 0.1 to 0.15 lb ai/A pre-plant incorporated, pre-emergence or at planting. PHI 0 days for forage, 30 days for grain harvest or fodder (stover). REI 12 hr. As preemergent, apply from 5 days before planting up to crop emergence. Apply in furrow or as band at planting.
- phorate (Thimet 20G) 0.056 to 0.075 lb ai/1,000 row ft at planting or cultivation, broadcast or banded but not in-furrow. REI 48 hr. Limit one application.
- tefluthrin (Force 3G) Group 3 insecticide at 0.0075 to 0.0094 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0 hr. Do not exceed 0.327 lb ai/A per year. Use only once per season.
- terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Band or furrow at planting.

Seed treatments

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

- thiamethoxam (Cruiser 5FS). Commercial treaters only. See label instructions.

Field and silage corn—Slug

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

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

Management—chemical control

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

Field and silage corn—Wireworm

Ctenicera and *Limonius* spp.

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

Management—cultural control

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

Management—chemical control

- beta-cyfluthrin (Baythroid XL) Group 3 insecticide at 0.12 to 0.16 oz ai/1,000 row ft (2.0 to 2.8 fl oz/A). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.088 lb ai/A per season.
- bifenthrin (Brigade 2EC, Capture LFR) Group 3A insecticide/miticide at 0.0023 to 0.0046 lb ai/1,000 row ft at plant; or 0.047 to 0.062 lb ai/A preplant incorporated. PHI 30 days for harvest, grazing, or cutting for feed. REI 12 hr. Do not exceed 0.1 lb ai/A at planting or 0.3 lb ai/A per season. Do not apply Capture LFR as foliar treatment.
- bifenthrin/chlorethoxyfos Group 1B insecticide
    - SmartChoice 5G at 3.0 to 3.5 oz/100 ft. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
    - SmartChoice HC at 1.15 to 1.67 oz/1,000 row ft. See spacing charts in label for actual application rates per A. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- bifenthrin/indol butyric acid (Empower 2) at 0.002 to 0.006 lb ai/1,000 row ft. PHI 30 days in furrow. REI 24 hr. Do not exceed 0.3 lb ai/A foliar and at planting.
- bifenthrin/zeta-cypermethrin (Hero) Group 3A insecticide at 0.04 to 0.1 lb ai/A in furrow (4.5 to 11.2 fl oz/A). See label for specific fl oz per 100 linear ft based on row spacing. PHI 30 days grain and stover; 60 days forage. REI 12 hr. Do not graze for 30 days after treatment. 0.099 lb/A zeta-cypermethrin and 0.398 lb/A bifenthrin per year.
- chlorethoxyfos/bifenthrin (SmartChoice 5G, SmartChoice HC) Group 1B insecticide—Smartchoice 5G application rate at 3.0 to 5.0 oz 1,000 row ft, SmartChoice HC 1.0 to 1.67 oz 1,000 row ft. See label for actual oz based on row spacing. REI 2 days or 3 days where annual rainfall is less than 25 inches. T-band over the row or apply in furrow. Apply with Smartbox system. Do not exceed one application per year.
- cyantraniliprole (Fortenza) at 0.125 to 0.5 lb ai/seed. REI 12 hr. Do not exceed 0.4 lb ai/A of cyantraniliprole products per year.
- cyfluthrin (Tombstone) insecticide at 0.12 to 0.16 fl oz 1,000 row ft (2.0 to 2.8 fl oz/A based on 30 in row spacing). PHI 0 days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed 0.175 lb ai/A per season
- ethoprop (Mocap 15G) Nematicide/insecticide at 1.2 oz ai/1,000 row ft. REI 48 hr or 72 hr where annual rainfall is less than 25 inches. One application per season. Incorporate in band above seed row.
- gamma-cyhalothrin (Declare) Group 3 insecticide at 0.0004 lb ai/1,000 row ft at plant. PHI 21 days. REI 24 hr. Do not exceed 0.06 lb ai/A from at plant and foliar treatments.
- lambda-cyhalothrin (Warrior II) Group 3 insecticide at 0.005 lb ai/1,000 row ft (planting). PHI 21 days. REI 24 hr. Do not exceed 0.12 lb ai/A from at plant and foliar applications.
- permethrin (Loveland Permethrin) Group 3 insecticide at 0.1 to 0.15 lb ai/A pre-plant or at-plant. PHI 0 days for forage, 30 days for grain harvest or fodder (stover). REI 12 hr. As preemergent, apply from 5 days before planting up to crop emergence. Apply in furrow or as band at planting.
- phorate (Thimet 20G) 0.056 to 0.075 lb ai/1,000 row ft at planting or cultivation, broadcast or banded but not in-furrow. REI 48 hr. Limit one application.
- tefluthrin (Force 3G) Group 3 insecticide at 0.0075 to 0.0094 lb ai/1,000 row ft. T-band or in-furrow at planting. REI 0 hr. Do not exceed 0.327 lb ai/A per year. Use only once per season.
- terbufos (Counter 15G) at 0.056 to 0.075 lb ai/1,000 row ft. REI 48 hr or 72 hr if annual rainfall is less than 25 inches. Band or furrow at planting.

Seed treatments

- abamectin/thiamethoxam (Avicta Duo Corn)—Apply as slurry to corn seed. Consult label.
- abamectin/thiamethoxam/azoxystrobin (Avicta Complete)—Refer to label for instructions.
- clothianidin (Poncho 600) at 0.25 to 0.5 mg ai/kernel or 0.22 lb ai/80,000 seed unit. Commercial treaters only.

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

See also:
Potato, Irish—Wireworm

Hop Pests

Ann Iskra, Raymond Seal, and Jonnetti Bernard

Latest review—March 2024

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

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

Hop—Armyworm

Includes bertha armyworm (*Mamestra configurata*)

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

Management—chemical control

- abamectin/bifenthrin (Athena) by ground for armyworms except beet armyworm at 0.068 to 0.12 lb ai/A. PHI 28 days. REI 12 hr. Do not make more than two applications of Athena per season. Do not make applications less than 21 days apart. Do not apply more than 0.019 lb ai/A of any abamectin formulation or 0.30 lb ai/A of any bifenthrin formulation per season. Group 6/3A insecticides.
- azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum application interval is 21 days. Group 3A insecticide.
- *Burkholderia* spp. strain A396. (Venerate XC, Venerate CG)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) for western yellowstriped armyworm at 0.045 to 0.098 lb ai/A. PHI 0 days. REI 4 hr. Up to four applications per year at 7-day intervals. Do not exceed 15.4 fl oz or 0.2 lb ai/A chlorantraniliprole-containing product per year. Group 28 insecticide.
- *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo CG)—See label for rates. PHI 0 days. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air for armyworms except beet armyworm at 0.20 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- naled (Dibrom 8E) at 0.9 lb ai/A. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. Apply in 100 to 200 gallons of water by air or 10 to 20 gallons of water by ground. Group 1B insecticide.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- spinetoram (Delegate WG) at 0.039 to 0.063 lb/Ai. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai per season. Group 5 insecticide.
- spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/A. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/A per season. Some formulations are OMRI-listed for organic use. Group 5 insecticide.

Hop—Corn earworm

Helicoverpa zea

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

Management—chemical control

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

Hop—Cutworm

Several species

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

Management—chemical control

- abamectin/bifenthrin (Athena) by ground for armyworms except beet armyworm at 0.068 to 0.12 lb ai/A. PHI 28 days. REI 12 hr. Do not make more than two applications of Athena per season. Do not make applications less than 21 days apart. Do not apply more than 0.019 lb ai/A of any abamectin formulation or 0.30 lb ai/A of any bifenthrin formulation per season. Group 6/3A insecticides.
- azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum interval between applications is 21 days. Group 3A insecticide.
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- pyrethrins/Azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/A. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/A per season. Group 5 insecticide.
- spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/A. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/A per season. Some formulations are OMRI-listed for organic use.. Group 5 insecticide.

Hop—European earwig

Forficula auricularia

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

Management—chemical control

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

Hop—Hop Flea Beetle

Psylliodes punctulatus

Pest description and crop damage Adults are about 0.083 (1/12) inch long, metallic black beetles, that when disturbed jump like a flea. Adults feed on leaves primarily in the spring causing shothole damage. Severe infestations can defoliate plants.

Management—chemical control

- azadirachtin (Several listed)—see listed rate. Only affective on immature stages larvae. Some formulations suggest an adjuvant be added for better results. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Sultrus, Baythroid XL, Leverage 360) at 0.025 lb ai/A. Maximum sessional total 0.125 lb ai/A (beta-cyfluthrin), 0.25 lb ai/A (cyfluthrin). Group 3A insecticide.
- cyfluthrin (Tombstone, Tombstone Helios) at 0.025 lb ai/A. PHI 7 days. REI 12 hr. Do not apply more than five times per crop season. Do not apply more than 0.125 lb ai/A per season of any formulation of cyfluthrin. Allow at least 14 days between applications. Group 3A insecticide.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5 to 7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.

Hop—Garden symphylan

Scutigerella immaculata

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

Management—chemical control

- ethoprop (Mocap EC) at 3 lb ai/A on baby hops (nonproducing) or producing hops. REI 72 hr. Group 1B insecticide.
    - *Baby hops, post-plant, pre-emergence:* apply as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row.
    - *Baby hops, pre-plant:* apply as a broadcast application and immediately incorporate into the top 2 to 4 inches of soil using a disc or rotary cultivator.
    - *Producing hops:* apply in the spring after pruning, but before stringing, or post-harvest as a broadcast application immediately incorporated into the top 2 to 4 inches of soil using a disc or rotary cultivator, or as a broadcast or band application followed by 1 to 2 inches of overhead irrigation. If applied by band, apply in band at least 2 feet wide over the row. PHI 90 days. Make only one application per year. Do not apply more than 3.0 lb ai/A per year. Do not apply to saturated soils which increases runoff or to dry soils which decreases effectiveness.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- thiamethoxam (Platinum) at 0.125 lb ai/A. PHI 65 days. REI 12 hr. Do not exceed 0.125 lb ai/A per season. Apply (1) to the soil as a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Group 4A insecticide.

See also: beet

Biology and Control of the Garden Symphylan

Hop—Hop aphid

Phorodon humuli

Pest description and crop damage Aphids overwinter as eggs on prune trees. Greenish to black, winged forms migrate to hops in May or June. Wingless forms on hops are pale yellowish green. They suck plant juices and excrete honeydew which can contaminate cones, especially when sooty mold colonizes the honeydew.

Management—chemical control

- *Beauveria bassiana* (Botanigard ES, Mycotrol 0)—See label for rates. PHI 0 days. REI 4 hr. Apply when pests first appear. Repeat applications as needed. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* strain GHA (BotaniGard 22WP, BoteGHA ES, Mycotrol ESO) at 0.027 to 0.22 lb ai/A. Apply at 5- to 10-day intervals. 0-day PHI. Some formulations are OMRI-listed for organic use.
- beta-cyfluthrin (Sultrus, Baythroid XL, Leverage 360) at 0.025 lb ai/A. Maximum sessional total 0.125 lb ai/A (beta-cyfluthrin), 0.25 lb ai/A (cyfluthrin). Group 3A insecticide.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum interval between applications is 21 days. Group 3A insecticide.
- *Burkholderia* spp. strain A396 (Venerate XC)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. OMRI-listed for organic use.
- *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- cyfluthrin (various formulations) at 0.025 lb ai/A. PHI 7 days. REI 12 hr. Do not apply more than five times per crop season. Do not apply more than 0.125 lb ai/A per season of any formulation of cyfluthrin. Allow at least 14 days between applications. Group 3A insecticide.
- flonicamid (BeLeaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 10 days. REI 12 hr. Do not make more than three applications per season. Do not apply more than 0.089 lb ai/A per application or 0.267 lb ai/A per season. Group 9C insecticide.
- flupyradifurone (Sivanto 200 SL) at 0.09 to 0.137 lb ai/A. PHI 21 days. REI 12 hr. Apply in a minimum of 25 gal per acre (ground) or 10 gal per acre (aerial). Do not apply more than 0.365 lb per acre per year. Group 4D insecticide.
- imidacloprid (various formulations) to the soil at 0.1 lb ai/A to 0.3 lb ai/A. PHI 60 days. REI 12 hr. One application to the soil per season applied as (1) a drip irrigation, (2) a subsurface side dress shank irrigation, or (3) a hill drench. Follow side dress and shank applications by furrow or sprinkler irrigations to ensure incorporation into the root zone. Do not apply more than 0.3 lb ai/A per season of any imidacloprid formulation. Group 4A insecticide.
- imidacloprid (various formulations) by ground or air at 0.1 lb ai/A. PHI 28 days. REI 12 hr. Allow at least 21 days between applications. Do not apply more than 0.3 lb ai/A per season of imidacloprid formulation. Group 4A insecticide.
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- imidacloprid/beta-cyfluthrin (Leverage 360) by ground or air at 0.055 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.125 lb ai/A of

any beta-cyfluthrin formulation, more than 0.250 lb ai/A of any beta-cyfluthrin/cyfluthrin formulation or more than 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.

- malathion (various formulations) at 0.63 to 1.89 lb ai/A. See label for rates. PHI 7 to 10 days; check label. REI 12 hr. Group 1B insecticide.
- naled (Dibrom 8E) at 0.9 lb ai/A. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. Group 1B insecticide.
- potassium salts of fatty acids (M-pede)—PHI 0 days. REI 12 hr. Some formulations are OMRI-listed for organic use.
- pymetrozine (Fulfill) at 0.125 to 0.188 lb ai/A. PHI 14 days. Apply before aphids reach damaging levels. Do not apply at lower than recommended rates. Do not apply by air. Do not apply more than 0.188 lb ai per application. Do not exceed 0.56 lb ai per season. Allow at least 14 days between applications. Group 9B insecticide.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- spirotetramat (Movento, Ultor) at 0.08 to 0.096 lb ai/A. PHI 7 days. REI 4 hr. Allow at least 14 days between applications. Do not apply more than 0.2 lb ai/A per season. Group 23 insecticide.
- thiamethoxam (Platinum) at 0.125 lb ai/A. PHI 65 days. REI 12 hr. Apply (1) to the soil as a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Do not exceed 0.125 lb ai/A per season. Group 4A insecticide.

Hop—Hop looper

Hypena humuli

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

Management—chemical control

- azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.
- beta-cyfluthrin (Sultrus, Baythroid XL, Leverage 360) at 0.025 lb ai/A. Maximum sessional total 0.125 lb ai/A (beta-cyfluthrin), 0.25 lb ai/A (cyfluthrin). Group 3A insecticide.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum interval between applications is 21 days. Group 3A insecticide.
- *Burkholderia* spp. strain A396 (Venerate XC)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. OMRI-listed for organic use.
- *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- cyfluthrin (various formulations) at 0.25 lb ai/A. PHI 7 days. REI 12 hr. Do not apply more than five times per crop season. Do not apply more than 0.25 lb ai/A per season of any formulation of cyfluthrin. Allow at least 14 days between applications. Group 3A insecticide.
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. PHI 28 days. REI 4 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- imidacloprid/beta-cyfluthrin (Leverage 360) by ground or air at 0.005 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.125 lb ai/A of any beta-cyfluthrin formulation, more than 0.250 lb ai/A of any beta-cyfluthrin/cyfluthrin formulation or more than 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/A. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/A per season. Group 5 insecticide.
- spinosad (Entrust, Success) at 0.06 to 0.10 lb ai/A. PHI 1 day. REI 4 hr. Allow at least five days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than five applications per season. Do not apply more than 0.47 lb ai/A per season. Some formulations are OMRI-listed for organic use. Group 5 insecticide.

Hop—Obliquebanded leafroller

Choristoneura rosaceana

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

Management—chemical control

- azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis* (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Repeat treatment as

needed. Some formulations are OMRI-listed for organic use. Group 11A insecticide.

- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum application interval is 21 days. Group 3A insecticide.
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. PHI 28 days. REI 12 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/A pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3A insecticide.
- spinetoram (Delegate WG) at 0.039 to 0.063 lb ai/A. PHI 1 day. REI 4 hr. Target eggs and small larvae. Allow at least 4 days between applications. Do not make more than two consecutive applications of group 5 insecticides. Do not make more than 3 applications per season. Do not apply more than 0.305 lb ai/A per season. Group 5 insecticide.

Hop—Omnivorous leaftier

Cnephasia longana

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

Management—chemical control

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

Hop—Prionus beetle

Prionus californicus

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

Management—chemical control

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

Hop—Root weevil

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

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

Management—chemical control

- *Beauveria bassiana* strain GHA (BotaniGard 22WP, BoteGHA ES, Mycotrol ESO) at 0.027 to 0.22 lb ai/A. Apply at 5- to 10-day intervals. 0-day PHI.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per

season. Minimum application interval is 21 days. For best results, apply as a foliar spray at night to the plant base and lower 3 feet of vine. Group 3A insecticide.

- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. REI 12 hr. PHI 28 days. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- pyrethrins/azadirachtin (Azera) at 0.013 to 0.0044 lb ai/A azadirachtin/0.014 to 0.048 lb ai/A pyrethrins. PHI 0 days. REI 12 hr. Apply when pest populations first appear. Reapply every 5-7 days as needed up to 10 times per season. Do not apply more than 0.050 lb ai/ a pyrethrins per season. Some formulations are OMRI-listed for organic use. Group 3 insecticide.
- thiamethoxam (Platinum) at 0.125 lb ai/A. PHI 60 days. REI 12 hr. Do not exceed 0.266 lb ai/A per season. Apply (1) to the soil a band on each side of the hop row, (2) by drip irrigation into the root zone, or (3) as a hill drench. Incorporate band and hill drench applications with irrigation within 24 hr. Group 4A insecticide.

Hop—Spider mite

Twospotted spider mite (*Tetranychus urticae*)

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

Management—chemical control

- abamectin (various formulations) at 0.009 to 0.019 lb ai/A. PHI 28 days. REI 12 hr. No more than two applications per season; do not apply second application within 21 days of first. Another compound must be used between abamectin applications. Do not apply more than 0.038 lb ai/A per season. Do not apply in less than 40 gal/A of water. Do not apply by air. Group 6 insecticide.
- acequinocyl (Kanemite 15 SC) at 0.3 lb ai/A. PHI 7 days. REI 21 hr. Do not apply by air or in less than 100 gals of water per acre. Allow at least 21 days between treatments. Do not make more than two treatments per season. Do not apply more than 0.6 lb ai/A per season. Do not use adjuvants or surfactants. Group 20B insecticide.
- azadirachtin (various formulations)—See label for rates. PHI 0 days. REI 4 hr. Works best on early larval stages. Applications can be repeated every 7 days or as needed. Some formulations are OMRI-listed for organic use.
- bifenazate (Acramite 50WS) at 0.38 to 0.75 lb ai/A. PHI 14 days. REI 12 hr. Do not apply in less than 50 gal/A. Do not make more than one application per season. Do not apply by air. REI 12 hr. Group 20D insecticide.
- bifenthrin (various formulations) at 0.06 to 0.1 lb ai/A. PHI 14 days. REI 12 hr. Do not exceed 0.1 lb ai/A per application or 0.3 lb ai/A per season. Minimum application interval is 21 days. For late-season control by air, apply at least 0.1 lb ai/A in at least 10 gal water/A. Group 3A insecticide.
- *Burkholderia* spp. strain A396 (Venerate XC)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. OMRI-listed for organic use.
- *Chromobacterium subtsugae* strain PRAA4-1 (Grandevo)—See label for rates. PHI 0 days. REI 4 hr. Apply when pest populations are low. Repeat as needed. Some formulations are OMRI-listed for organic use.
- crop/horticultural/stylet oils (various formulations) at 1 to 2 gal per 100 gal water. PHI 0 days. Follow label directions. Local SLN registrations may apply; verify label is in effect before use. Apply as needed. Thorough coverage is essential. Do not apply propargite (Omite) along with, or for 30 days following, an oil spray, or when temperatures exceed 90°F. Some formulations are OMRI-listed for organic use.
- cyflumetofen (Nealta) at 0.18 lb ai/A in a minimum of 100 gal water per acre. PHI 14 days. Do not make applications at intervals shorter than 14 days. Do not exceed 0.36 lb ai/A per season or two applications.
- etoxazole (Zeal) at 0.135 to 0.180 lb ai/A. PHI 7 days. REI 12 hr. Do not make more than one application per season. Do not apply more than 4 oz per season. Group 10B insecticide.
- fenazaquin (Magister SC) at 0.42 to 0.48 lb ai/A. PHI 7 days. REI 12 hr. Apply only once per year. Do not apply more than 0.48 lb ai/A per year. Do not apply by air or through any type of irrigation system. Group 21 insecticide.
- fenpyroximate (Fujimite 5EC) at 0.105 to 0.158 lb ai/A. PHI 15 days. REI 12 hr. Apply before mite populations exceed 5 per leaf. Use in sufficient volume to ensure adequate coverage. Spray concentrations above 100 ppm are recommended; see label. Do not make more than one application per season. Do not exceed 0.158 lb ai/A per season. Do not apply by air or through any type of irrigation system. Rotate at least two other miticides between fenpyroximate applications. Group 21A insecticide.
- hexythiazox (Savey 50DF) at 0.125 to 0.187 lb ai/A. PHI Apply up to burr formation. REI 12 hr. Apply only once per season. Savey controls mites through activity on eggs and immature stages. Although it doesn't directly control mite adults, it renders eggs laid by treated female adults nonviable. Complete coverage of leaf surface is essential for effective control. Group 10A insecticide
- imidacloprid/bifenthrin (Brigadier, Swagger) by ground or air at 0.06 to 0.20 lb ai/A. PHI 28 days. PHI 12 hr. Do not apply more than 0.1 lb ai/A of imidacloprid or more than 0.1 lb ai/A of bifenthrin per application. Do not apply more than 0.30 lb ai/A of any bifenthrin formulation or 0.30 lb ai/A of any imidacloprid formulation per season. Group 4A/3A insecticides.
- malathion (various formulations) at 0.63 to 1.89 lb ai/A. See label for rates. PHI 7 or 10 days; check label. REI 12 hr. Group 1B insecticide.
- naled (Dibrom 8E) at 0.94 lb ai/A. PHI 7 days. REI 48 hr. Up to five applications per season at 14-day intervals. A legal pesticide use not found on the pesticide label and not recommended by University of Idaho personnel. Group 1B insecticide.
- potassium salts of fatty acids (M-pede)—Check label for rates. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- propargite (Comite, Comite II, Omite 6E) at 1.5 to 2.5 lb ai/A. See label for rates. PHI 14 days. REI 21 days. Before applying, check current label for re-entry rules, tank-mix limitations, and other restrictions. Do not apply propargite during, with, or following an oil spray. Do not apply more than twice a season. Do not use propargite with nutrient sprays or when daytime temperatures are expected to exceed 95°F. Do not apply in combination with petroleum-based foliar sprays. Application with alkaline materials such as lime sulfur or Bordeaux mixture reduces effectiveness. Group 12C insecticide.

- spirodiclofen (Envidor 2SC) at 0.28 to 0.386 lb ai/A. PHI 7 days. REI 12 hr. No more than one application per season. No more than 0.386 lb ai/A per season. Minimum application volume 100 gpa by conventional air blast sprayers or 30 gpa using high velocity, low volume sprayers. Group 23 insecticide.
- spirotetramat (Movento, Ultor) at 0.08 to 0.096 lb ai/A. PHI 7 days. REI 4 hr. Allow at least 14 days between applications. Do not apply more than 0.2 lb ai/A per season. Group 23 insecticide.
- sulfur (various formulations) at 3 to 45 lb ai/A; see label for rates. REI 24 hr. Do not apply in combination with or within 2 weeks of an oil - or petroleum-based foliar spray, such as emulsifiable concentrates. Sulfur may burn foliage, flowers, or cones if applied when temperatures are high. Use when temperature is above 85º F is not recommended.

Hop—Western spotted cucumber beetle

Diabrotica undecimpunctata undecimpunctata

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

Management—chemical control

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

Mint Pests

Christy Tanner and Navneet Kaur

Latest revision—March 2024

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

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

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

Mint—Alfalfa looper and cabbage looper

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

Pest description and crop damage Larvae of both species are pale green with white lines on backs and sides. Larvae have three pairs of abdominal prolegs, whereas cutworms and armyworms have five pair. Larvae of loopers move in a "looping" manner similar to inchworms and range in size from 1 to 1.5 inches long. Moths are gray-brown with a silvery oval and a U-shaped white or cream-colored spot in the shape of a dog leg on forewings.

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

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

Management—biological control

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

Management—cultural control

Larval feeding damage in May and June, particularly in western Oregon, is usually confined to those leaves that appear in the spring on the first regrowth nodes. The great majority of these leaves will become shaded out, senesce, and fall well before harvest. Thus, treating fields with an insecticide specifically for loopers at this stage is generally uneconomical and may reduce potential for biological control by killing beneficial insects.

Management—chemical control

- acephate (Acephate 90WDG, Orthene 75 S) Acephate 90WDG treat at 1 lb ai/A, Orthene 75S at 1.3 lb ai/A. PHI 14 days. REI 24 hr. Apply to eggs or at first detection of pest. Retreatment interval 7 days with Acephate 90WDG and repeat application 3 days with Orthene 75 S. Do not exceed 2 lb ai/A per season, nor make more than two applications per crop season. Grazing of animals on treated areas, and feeding of spent mint hay to animals, are prohibited.
- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis*—There are several products containing various amounts of *Bt*; check each label for application rate. PHI 0 days. REI 4 hr. Treat mint when larvae are small. Some formulations are OMRI-listed for organic use.

- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 3 days. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.2 lb ai/A or 4 applications per calendar year. May be applied by chemigation.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. May be applied by chemigation. Apply in at least 10 gal water/A. OMRI-listed for organic use.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per season or make more than 4 applications per year. May be applied by chemigation. Apply in at least 20 gal watechr/A.
- methomyl (Lannate SP) at 0.9 lb ai/A. PHI 14 days. REI 48 hr. Do not apply more than 1.8 lb ai/A per growing season or 4 applications. Restricted use.
- methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/A. PHI 14 days. REI 4 hr. Do not apply more than 1.0 lb ai/A per year. Time applications to small larvae and egg masses. Time applications to small larvae and egg masses.
- spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not apply more than 0.305 lb ai/A per crop or make more than 4 applications per year. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad). Target eggs and small larvae.
- spinosad (Success, Entrust SC) at 0.062 to 0.156 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb ai/A per crop year, make more than four applications per calendar year or more than three applications per crop. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad). Target eggs and small larvae. Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early season and 0.12 to 0.25 lb ai/A mid to late season. PHI 14 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 1 lb ai/A per season. Apply in at least 8 gal water/A to small plants and 10 gal water/A to dense stands. Addition of a spreader-binder is recommended. Addition of a spreader-binder is recommended.

Mint—Aphid

Includes mint aphid (*Ovatus crataegarius*)

Pest description and crop damage Wingless forms are apple green to yellow-green sometimes with mottled, darker markings and are 1.5 to 2mm in length. Winged forms have a dark brown head and thorax. Large populations stunt and distort stems and leaves, make plants more susceptible to water stress, and secrete honeydew, which can help to sunburn leaves or cover them with black, sooty mold.

These insects overwinter on the base of mint plants and on roots. Females give birth to nymphs during the spring. Mint aphid can have 10 to 12 generations in a single year.

Management—chemical control

- acephate (Acephate 90WDG, Orthene) at 1 lb ai/A. PHI 14 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 lb ai/A per season, nor make more than two applications per crop season. The grazing of animals on treated areas, and the feeding of spent mint hay to animals are prohibited.
- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol) Check each label for application rate. PHI 0 days. REI 4 hr. Most effective when used at first detection. Some formulations are OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/A. PHI 0 days. REI 4 hr. Suppression only. OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.05 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. May be applied by chemigation. Apply in at least 10 gal water/A. OMRI-listed for organic use.
- flonicamid (Beleaf 50SG) at 0.062 to 0.089 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.267 lb ai/A per season or 3 applications per season. Apply in at least 20 gal water per acre. Best control is achieved when applied before large populations develop.
- malathion (Gowan Malathion 8) at 0.94 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per year.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.188 lb ai/A per season. Do not use less than 10 GPA for ground applications or 5 GPA for aerial applications.
- pyrethrins—Some formulations are OMRI-listed for organic use.

Mint—Armyworm and cutworm

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

See also:

Mint—Redbacked cutworm

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

Mint cutworm are large, 1.5 to 2 inches in length, yellow, tan, or green larvae with black spots over the body, similar to corn earworm. Damage is similar to that of the variegated cutworm and alfalfa looper, but this insect seldom is a problem of economic importance on mint. Spotted cutworm larvae vary in color, but most are dark brown to black, with distinct, triangular markings on the back.

Scouting and thresholds Scout for larvae beginning in late June to determine the need for insecticide application to prevent oil yield loss. Inspect surface of the soil under the mint canopy after shaking stems to dislodge larvae. Do this in a number of sites throughout the field. Carefully look for larvae in soil cracks, under leaves, and in old, brown, curled leaves. Record the number of larvae per sq ft. Treatment levels can vary from one to four larvae per sq ft depending on time to harvest, biological controls observed, and price of oil. Chemical treatments are most effective when larvae are from 2nd to 4th instar.

Management—biological control

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

Management—chemical control

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

- acephate (Acephate 90WDG, Orthene) at 1 lb ai/A. PHI 14 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 lb ai/A per season, nor make more than two applications per crop season. The grazing of animals on treated areas, and the feeding of spent mint hay to animals are prohibited.
- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/Acre. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A. PHI 0 days. REI 4 hr. Armyworms only. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 3 days. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.2 lb ai/A or 4 applications per calendar year. May be applied by chemigation.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant. Cutworms only.
- *Chromobacterium subtsugae* (Grandevo) at 0.3 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. May be applied by chemigation. Apply in at least 10 gal water/A. Armyworms only. OMRI-listed for organic use.
- indoxacarb (Avaunt) at 0.065 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.26 lb ai/A per season or make more than 4 applications per year. May be applied by chemigation. Apply in at least 20 gal water/A.
- methomyl (Lannate SP) at 0.9 lb ai/A. PHI 14 days. REI 48 hr. Do not apply more than 1.8 lb ai/A per growing season or 4 applications. Most effective on larvae smaller than 0.5 inch. Restricted use.
- methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/A. PHI 14 days. REI 4 hr. Do not apply more than 1.0 lb ai/A per year. Time applications to small larvae (2nd instar) and egg masses.
- spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not apply more than 0.305 lb ai/A per crop or make more than 4 applications per year. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad).
- spinosad (Success, Entrust SC) at 0.062 to 0.156 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.45 lb ai/A per crop year, make more than four applications per calendar year or more than three applications per crop. Target eggs and small larvae. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad). Entrust SC is OMRI-listed for organic use.
- tebufenozide (Confirm 2F) at 0.09 to 0.12 lb ai/A early season and 0.12 to 0.25 lb ai/A mid to late season. PHI 14 days. REI 4 hr. Retreatment interval 10 days. Do not exceed 1 lb ai/A per season. Apply in at least 8 gal water/A to small plants and 10 gal water/A to dense stands. Addition of a spreader-binder is recommended.

Mint—European cranefly

Tipula paludosa

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

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

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

Scouting and thresholds Look for the large adults of *T. paludosa* flying in fields in August and September. Take soil samples and screen soil to a

depth of 2 to 4 inches from mid to late October through June in order to determine larval populations. In spring, look for clipped uprights and locate larvae in soil nearby. Larval numbers in excess of 10 per sq ft may injure mint.

Management—chemical control

No insecticides are registered.

Mint—Garden symphylan

Scutigerella immaculata

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

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

Scouting and thresholds There are two modes for scouting symphylans—the potato bait method and soil sample method. The potato bait method allows greater visibility and likelihood of identifying high numbers. To bait symphylans, dig approximately four to six inches into soil and place half a potato and cover with solid plastic container. Check baits after 1 to 3 days. Lift potato and count symphylans on soil and then on potato. For soil sampling method, take soil samples roughly a standard shovel width (roughly 1 cubic ft) to a depth of 8 to 12 inches. Symphylans usually are sampled in April, May, and June shortly after irrigation or rain when soil is moist. Soil should be nearly at carrying capacity, but sufficiently dry so it fractures or crumbles easily, exposing symphylans in natural tunnels, crevices, worm holes, etc. Damage to mint likely occurs at densities of five to ten per cubic ft of soil.

Management—chemical control

- 1,3-dichloropropene (Telone II) at 18 to 35 gal/A only as a broadcast treatment. REI 5 days. See labels for use rate and application methods.
- ethoprop (Mocap EC or 15G) at 3 lb ai/A (6 lb ai/A if nematodes also a problem). PHI 225 days. REI 48 to 72 hr. Make only one application whether pre-plant or post-harvest per growing season. Apply in 20 to 30 gal water/A. Broadcast over the field and incorporate into the soil to a depth of at least 2 to 4 inches, during or immediately following application by mechanical means, including by rotary tiller, rotary hoe, springtooth harrow, or by double discing, or by immediate application of 1 to 2 inches of overhead irrigation. Repeat irrigation before soil dries. Restricted use.
- metam sodium or metam potassium (Sectagon-K54 or -42) at up to 360 lb ai/A. REI 5 days. See labels for use rate and application methods. See labels for use rate and application methods.

See also:

Biology and Control of the Garden Symphylan

Mint—Grasshopper

Includes

Clearwinged grasshopper (*Camnula pellucida*)

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

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

Management—chemical control

- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant.
- malathion (Gowan Malathion 8) at 0.94 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per year. Malathion is registered for use on mint to control other pests. Field use indicates it controls grasshoppers effectively. Note: Summer cutworm sprays help control grasshoppers.
- thiamethoxam (Actara) at 0.047 to 0.063 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.188 lb ai/A per season. Do not use less than 10 GPA for ground applications or 5 GPA for aerial applications.

Mint—Ligurian Leafhopper

Ligurian leafhopper (*Eupteryx decemnotata*)

Pest description and crop damage Adults are tiny, less than 0.12 inches, yellowish-green with a characteristic pattern of spots on the head and the wings. The Ligurian leafhopper is an important pest in cultivations of plants in the family Lamiaceae (mint). Just like other leafhoppers, they are sap-feeding insects causing damage by puncturing cells and removing the contents. The characteristic stippling is produced when pest density is high. The damage can be mistaken for thrips or mite injury.

Biology and Life History This is a new species first detected in Oregon in 2020. Leafhoppers typically lay their eggs in stems, leaf tissues and petioles of plants, so they are nearly impossible to detect. After eggs hatch leafhoppers will pass through five nymphal instars over the course of 20 days before reaching adult stage. Like adults, nymphs can hop.

Management Since pest status is unknown, no information exists.

Mint—Mint flea beetle

Longitarsus waterhousei

Pest description and crop damage Adults are small, 2mm long, pale brown to brownish-yellow flea beetles feed on mint foliage producing "shot-holed leaves." These usually are noticed first in late June, July. The main damage is by the larvae, also only 3mm long, which feed on and severely damage roots in late April, May, and June.

Biology and life history Eggs overwinter in the soil and hatch from early April through May. Larvae feed on roots and tunnel rhizomes through early June. Adults emerge in late June and July and feed, mate, and deposit eggs in or on the soil in July and August. There is a 2- to 3-week pre-ovipositional phase before females lay eggs. Insecticides applied to control adults should be used at this time to prevent larval infestations. There is one generation per year.

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

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

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

Management—cultural control

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

Management—chemical control

These are directed at the adult stage.

- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.05 to 0.1 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant.
- malathion (Gowan Malathion 8) at 0.94 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per year. Apply malathion as a full coverage spray after adults emerge, usually in early July. Time sprays for early morning hours when beetles are on foliage and easiest to kill.
- methomyl (Lannate SP) at 0.68 to 0.9 lb ai/A. PHI 14 days. REI 48 hr. Do not apply more than 1.8 lb ai/A per growing season or 4 applications. Apply Lannate as a full coverage spray after adults emerge, usually in early July. **Restricted use pesticide**.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.188 lb ai/a per season. Do not use less than 10 GPA for ground applications or 5 GPA for aerial applications.

Mint—Mint root borer

Fumibotys fumalis

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

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

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

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

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

Management—chemical control

- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 3 days. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.2 lb ai/A or 4 applications per calendar year. May be applied by chemigation.

- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A (ground) or 5 gal water/A (aerial). Do not use an adjuvant.
- ethoprop (Mocap EC or 15G) at 3 lb ai/A (6 lb ai/A if nematodes also a problem). PHI 225 days. REI 48 to 72 hr. Make only one application whether preplant or post-harvest per growing season (either preplant, or after last harvest of the growing season). Apply in 20 to 30 gal water/A. Broadcast over the field and incorporate into the soil to a depth of at least 2 to 4 inches, during or immediately following application by mechanical means, including by rotary tiller, rotary hoe, springtooth harrow, or by double discing, or by immediate application of 1 to 2 inches of overhead irrigation. Repeat irrigation before soil dries. **Restricted use pesticide**.
- thiamethoxam (Actara) at 0.023 to 0.047 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not apply more than 0.188 lb ai/A per season.

Mint—Mint stem borer

Pseudobaris nigrina

Pest description and crop damage Adults look like weevils. Larvae are small white grub, 0.08 to 0.16 inch long, with a brown head and no legs. Damage is to the main root; females bore into the base of a stem laying a single egg at the base of stock. Larvae hatch, feeding on tissues of the main stalk, causing injury or death to the central stalk, which usually breaks off. A female lays approximately 100 eggs per season. It is found in eastern Oregon and Idaho. It can infest mint rootstock for export.

Management—chemical control

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

Mint—Painted lady or thistle butterfly

Vanessa cardui

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

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

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

Management—chemical control

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

Mint—Redbacked cutworm

Euxoa ochrogaster

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

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

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

Management—cultural control

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

Management—chemical control

- acephate (Orthene 97) at 1 lb ai/A. PHI 14 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 lb ai/A per season, nor make more than two applications per crop season. Apply through a specified sprinkler irrigation system or with ground spray equipment in at least 10 gal/A water. Grazing of animals on treated areas, and feeding of spent mint hay to animals are prohibited. Late evening or night applications are most effective. Apply in no more than 0.15 inch water with center pivot, wheel roll or solid set sprinkler irrigation equipment. SLN OR-090026.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 3 days. REI 4 hr. Retreatment interval 14 days. Do not exceed 0.2 lb ai/A or 4 applications per calendar year. May be applied by chemigation.
- chlorantraniliprole/thiamethoxam (Voliam Flexi) at 0.1 to 0.125 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 14 days. Do not exceed 15 oz/A Voliam Flexi or 0.188 lb ai/A of thiamethoxam or 0.2 lb ai/A of chlorantraniliprole per season. Apply in at least 10 gal water/A

(ground) or 5 gal water/A (aerial). Do not use an adjuvant.

- methoxyfenozide (Intrepid 2F) at 0.16 to 0.25 lb ai/A. PHI 14 days. REI 4 hr. Do not apply more than 1.0 lb ai/A per year. Time applications to small larvae and egg masses.

Mint—Root weevil

Black vine weevil (*Otiorhynchus sulcatus*)
Strawberry root weevil (*O. ovatus*)

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

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

Management—chemical control

- acephate (Acephate 90WDG, Orthene) at 1 lb ai/A. PHI 14 days. REI 24 hr. Retreatment interval 7 days. Do not exceed 2 lb ai/A per season, nor make more than two applications per crop season. Grazing of animals on treated areas, and feeding of spent mint hay to animals are prohibited. For control of adult weevils. Apply late May through early June after adults emerge but before egg laying when weevils are feeding actively on foliage. Apply on warm, still evenings, usually between 10 pm and 2 am. Two applications 10 to 14 days apart may be necessary to reduce large infestations, particularly in central Oregon.
- azadirachtin (AzaMax) at 0.012 to 0.044 lb ai/A. PHI 0 days. REI 4 hr. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* (Mycotrol) Check each label for application rate. PHI 0 days. REI 4 hr. Most effective when used at first detection. Some formulations are OMRI-listed for organic use.

Mint—Slug

Includes

European black slug (*Arion ater)*
Gray garden slug (*Deroceras reticulatum*)
Great gray garden slug (*Limax maximus*)
Marsh slug (*Deroceras laeve*)

See also:
Slug Control

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

Management—chemical control

- iron phosphate/spinosad (Bug-N-Sluggo) at 0.2 to 0.44 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not make more than 4 applications per calendar year or more than 3 applications per crop, or apply more than 0.45 lb ai/A spinosad per crop. OMRI-listed for organic use.

Mint—Spider mite

Includes spider mite (*Tetranychus urticae*)

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

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

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

Management—cultural control

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

Management—biological control

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

Management—chemical control

- abamectin (ABBA, Agri-Mek SC) at 0.0096 to 0.014 lb ai/A. PHI 28 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.042 lb ai/A per season, apply more than twice consecutively or make more than three applications per year. Apply in at least 20 gal water/A (ground) or 5 gal water/A (aerial). Do not allow livestock to graze or feed treated foliage to livestock. To avoid illegal residues, Agri-Mek SC must be mixed with a non-ionic activator type wetting, spreading and/or penetrating spray adjuvant.
- bifenazate (Acramite 4SC) at 0.375 to 0.75 lb ai/A. PHI 7 days. REI 12 hr. One application per year only. Apply by chemigation in 0.1 to 0.2 acre-inches of water.
- *Burkholderia* spp. (Venerate XC) at 2 to 4 quarts/A. PHI 0 days. REI 4 hr. Suppression only. OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. May be applied by chemigation. Apply in at least 10 gal water/A. OMRI-listed for organic use.
- etoxazole (Zeal) at 0.09 to 0.18 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed 0.18 lb ai/A per season or make more than one application per season. Do not use below use rate 2.0 oz/A (0.09 lb ai/A) as this may result in poor control and contribute to the development of resistance to etoxazole among mite populations.
- fenazaquin (Magister SC) at 0.3 to 0.48 lb ai/A. PHI 7 days. REI 12 hr. Do not exceed application rate of 36 fl oz of product (0.48 lb ai/A) per year or make more than one application per year. Apply in at least 20 gal water per acre. Apply this product before bloom.
- fenpyroximate (FujiMite) at 0.05 to 0.1 lb ai/A. PHI 1 day. REI 12 hr. Retreatment interval 7 days. Do not apply more than 0.2 lb ai/A per growing season or 2 applications. Apply in at least 25 gal water/A. Do not apply through any type of irrigation system. Do not apply through any type of irrigation system.
- hexythiazox (Onager Optek) at 0.094 to 0.156 ai/A. PHI 30 days. REI 12 hr. One application per year. Check SLN label for minimum water volume. SLN OR-170009; ID-170003; WA-170005.
- malathion (Gowan Malathion 8) at 0.94 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 3 applications per year.
- propargite (Omite 6E, Comite) at 1.5 to 2.0 lb ai/A. PHI 14 days. REI 7 days. Retreatment interval 7 days. Do not exceed 4.1 lb ai/A or two applications per year. Apply in at least 20 gal water/A. Do not feed treated mint to livestock. Restricted use.
- spiromesifen (Oberon) at 0.125 to 0.25 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Do not apply more than 3 times per season and do not exceed 0.75 lb ai/A per season. Do not apply while mint is in flower. Do not apply when bees are foraging on mint. SLN OR-200013; WA-170012.

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

Mint—Thrips

Frankliniella spp.

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

Management—cultural control

Avoid water stress with proper irrigation regime.

Management—chemical control

- *Beauveria bassiana* (Mycotrol) Check each label for application rate. PHI 0 days. REI 4 hr. Most effective when used at first detection. May require 3 to 5 intervals. Some formulations are OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. May be applied by chemigation. Apply in at least 10 gal water/A. OMRI-listed for organic use.
- spinetoram (Radiant SC) at 0.031 to 0.094 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 4 days. Do not apply more than 0.305 lb ai/A per crop or make more than 4 applications per year. Suppression only. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad).
- spinosad (Success, Entrust SC) at 0.062 to 0.156 lb ai/A. PHI 7 days. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.45 lb ai/A per crop year, make more than four applications per calendar year or more than three applications per crop. Suppression only. Do not make more than 2 successive applications of this or other group 5 insecticides (spinetoram and spinosad). Entrust SC is OMRI-listed for organic use.

Mint—Wireworm

Limonius spp.

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

Management—chemical control

- 1,3-dichloropropene (Telone II, C-17, or C-35) at 20 gal/A. REI 5 days. For preplant fumigation to be successful, soils need to be warm and moist. Evenly broadcast by soil injection to a depth of 14 inches. Note: When ethoprop (MOCAP) is used pre-plant at rates to control garden symphylan or nematodes, wireworms are often suppressed.

- chloropicrin (Strike 100CP) at up to 174 lb ai/A. REI 5 days. See labels for use rate and application methods.

See also:
Potato, Irish—Wireworm

Small Grain Pests

Christy Tanner and Tiziana Oppendisano

Latest revision—March 2024

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

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

Small grain—Aphid

Includes

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

Pest description and crop damage Aphids are of various colors—green, yellow, reddish. Cornicles, a pair of small tube-like structures on the posterior abdomen of aphids, are visible in most species, but may vary in size. Some species are important as vectors of *Barley yellow dwarf virus* (BYDV), which can negatively impact yield and quality of small grains, especially winter wheat and winter barley. Attempts to reduce incidence of BYDV by controlling established populations of aphids have not been successful. Seed treatment insecticides of the neonicotinoid group have reduced BYDV incidence especially when used in combination with delayed fall planting.

Sampling and thresholds

To control aphids, insecticide application may be considered. However, management thresholds, albeit subjective, vary depending on the species. For some of the more damaging aphids, such as greenbug, an average from 5 to 15 aphids per tiller (or stem) at the seedling stage, and 10 to 25 aphids per stem after boot may require management. However, there is rarely a need to spray for aphids in small grains. Insecticide applications after grain is in the milk stage of ripening are of no value. In rare instances, foliar insecticide may need to be applied prior to harvest if the honeydew produced by heavy aphid presence could interfere with combine function.

Management—biological control

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

Aphid predators and parasitoid wasps are important. Do not apply broad-spectrum foliar insecticides until you have examined the field for the presence of predators or parasitized aphids (a.k.a “mummified” aphids). Syrphid fly larvae and ladybird beetle larvae are common predators of value that reduce aphid populations; therefore, it is important to familiarize yourself with all developmental stages of these beneficial insects. The wasp *Diaeretiella rapae* is a common and effective parasitoid of Russian wheat aphid in intermediate rainfall in southeast Washington.

Management—chemical control

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

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

Seed treatment

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

- clothianidin (NipsIt Inside) at 0.75 to 1.79 fl oz (0.029 to 0.07 lb ai) /100 lb seed on-farm application. REI 12 hr. Do not exceed 0.2 lb ai/A clothianidin per year. Records of use as described in NZS 8409 Management of Agrichemicals must be kept if using 3 litres or more of

NipsIt Inside within 24 hours.

- imidacloprid (Gaucho 600F) at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) /100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr.
- imidacloprid/captan/carboxin (Enhance AW) at 4 oz per 100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr. Wheat, oats, barley.
- imidacloprid/metalaxyl/tebuconazole (GauchoXT) at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. REI 24 hr. Groundwater advisory: metalaxyl is known to leach through soil into groundwater under certain conditions as a result of agricultural use. Wheat, oats, barley.
- thiamethoxam (Cruiser 5FS, Warden Cereals 360) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) /100 lb seed; (Crusier Vibrance Quattro). REI 12 hr. Ground water advisory.

Foliar spray

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

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- azadirachtin (Aza-Direct, Ecozin 3EC) at 0.0125 to 0.043 lb ai/A. PHI 0 days. REI 4 hr. Best results can be obtained following 2 to 3 applications made at 7- to 10-day intervals. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* GHA (Mycotrol ES, Mycotrol ESO) at 0.5 to 1 quart/A. PHI 0 days. REI 4 hr. Repeat application may be necessary 2 to 5 days after initial application. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season. For best control, applications must be made before aphids damage the plants.
- *Chromobacterium subtsugae (*Grandevo WDG) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- dimethoate (Dimethoate 400) at 0.25 to 0.375 lb ai/A. PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Ground water advisory. Wheat only.
- fenpropathrin (Danitol) at 0.2 lb ai/A. REI 24 hr. Do not exceed 0.2 lb ai/A per season. One treatment per season. Apply before the boot stage of growth. Barley only.
- flupyradifurone (Sivanto 200 SL) at 0.09 to 0.18 lb ai/A. PHI 7 days forage; 21 days grain, stover or straw. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.365 lb ai/A per year. Ground water advisory.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments per year. Barley, oat, rye and wheat.
- methomyl (Lannate SP) at 0.225 to 0.45 lb ai/A. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/A per season. Do not exceed 4 applications per season. Wheat only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- sulfoxaflor (Transform WG) at 0.023 to 0.047 lb ai/A. PHI 14 days grain or straw, 7 days grazing, forage, fodder, hay harvest. REI 24 hr. Retreatment interval 14 days. Do not exceed 0.09 lb ai/A per year. Limit 2 treatment per crop.
- thiamethoxam (Actara) at 0.0625 lb ai/A. PHI 21 days. REI 12 hr. Retreatment interval 7 days. Do not exceed 0.125 lb ai/A per year. Ground water advisory. Barley only.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Russian wheat aphid

Diuraphis noxia

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

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

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

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

Fall—seedlings (1 tiller); 10% of plants infested.

Fall—larger plants; treat if plants are stressed or there is danger of winter kill.

Spring—winter grain green-up to appearance of first node; 5% of plants with reproducing populations and fresh damage.

Spring—winter grain appearance of first node to head emergence; 10% of tillers infested.

Spring—spring grain emergence to head emergence; 10% of tillers infested.

Spring—head emergence to soft dough; treat only if heavy populations (i.e., more than 20 aphids per plant) develop on 10 to 20% of flag leaves or stems. After the soft dough stage, insecticide treatment will have little or no benefit.

Management—chemical control

Seed treatment

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

- clothianidin (NipsIt Inside) at 0.75 to 1.79 fl oz (0.029 to 0.07 lb ai) /100 lb seed on-farm application. REI 12 hr. Do not exceed 0.2 lb ai/A clothianidin per year.
- imidacloprid (Gaucho 600F) at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) /100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr.
- imidacloprid/captan/carboxin (Enhance AW) at 4 oz per 100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr. Wheat, oats, barley.
- imidacloprid/metalaxyl/tebuconazole (GauchoXT) at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. REI 24 hr. Groundwater advisory: metalaxyl is known to leach through soil into groundwater under certain conditions as a result of agricultural use. Wheat, oats, barley.
- thiamethoxam (Cruiser 5FS) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) /100 lb seed. REI 12 hr. Ground water advisory.

Foliar spray

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

- *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/A. PHI 0 days. REI 4 hr. Repeat application may be necessary 2 to 5 days. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season. For best control, applications must be made before aphids damage the plants.
- cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Best control is obtained before insects begin to roll leaves.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- methomyl (Lannate SP) at 0.225 to 0.45 lb ai/A. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/A per season. Do not exceed 4 applications per season. Wheat only.
- sulfoxaflor (Transform WG) at 0.023 to 0.047 lb ai/A. PHI 14 days grain or straw, 7 days grazing, forage, fodder, hay harvest. REI 24 hr. Retreatment interval 14 days. Do not exceed 0.09 lb ai/A per year. Limit 2 treatment per crop.

Small grain—Barley thrips

Limothrips denticornis

Pest description and crop damage Black or brownish, winged or wingless, small slender insects between 0.03 and 0.0625 inch long. Thrips feed on

the cell contents of the plant foliage, which results in whitish/silverish look of the infested plants and fields. When abundant, they may injure flowers and reduce yields. Because of their small size, they are hard to locate. Gently unroll leaves or tap plants on a white background to inspect for their presence.

Management—chemical control

Foliar spray

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- azadirachtin (Aza-Direct, Ecozin 3EC) at 0.0125 to 0.043 lb ai/A. PHI 0 day. REI 4 hr. Best results can be obtained following 2-3 applications made at 7- to 10-day intervals. Some formulations are OMRI-listed for organic use.
- *Chromobacterium subtsugae* (Grandevo WDG) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- fenpropathrin (Danitol) at 0.2 lb ai/A. REI 24 hr. Do not exceed 0.2 lb ai/A per season. One treatment per season. Apply before the boot stage of growth. Barley only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Brown wheat mite

Petrobia latens

Pest description and crop damage Young mites are red-orange; later, they become dark brown with lighter colored legs. The front legs are usually held straight in front, elongated and almost twice as long as the other legs. Feeding gives foliage a mottled appearance and stunts plants. It has been a problem primarily in barley, but it could also attack wheat and other small grains, ryegrass, some legumes, onions, and carrots.

Management—chemical control

Foliar spray

- *Chromobacterium* subtsugae (Grandevo WDG) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- dimethoate (Dimethoate 400) at 0.16 to 0.25 lb ai/A. PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Ground water advisory. Wheat only.
- gamma-cyhalothrin (Declare) at 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season. Suppression only.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season. Suppression only.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year. Suppression only.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.

Small grain—Cereal leaf beetle

Oulema melanopus

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

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

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

Management—biological control

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

Management—chemical control

Foliar spray

- alpha-cypermethrin (Fastac EC) at 0.012 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/A. PHI 0 days. REI 4 hr. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.008 to 0.014 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- *Chromobacterium subtsugae* (Grandevo WDG) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.

- cyfluthrin (Tombstone) at 0.016 to 0.028 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- diflubenzuron (Dimilin 2L) at 0.0625 lb ai/A. PHI for grain and straw 50 days; forage 3 days; hay 15 days. REI 12 hr. One treatment per season. Barley, oats, triticale, and wheat.
- fenpropathrin (Danitol) at 0.2 lb ai/A. REI 24 hr. Do not exceed 0.2 lb ai/A per season. One treatment per season. Apply before the boot stage of growth. Barley only.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- methomyl (Lannate SP) at 0.225 to 0.45 lb ai/A. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/A per season. Do not exceed 4 applications per season. Wheat only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- spinetoram (Radiant SC) at 0.0156 to 0.047 lb ai/A. PHI 21 days for grain and straw; 3 days for forage, fodder, or hay harvest. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.141 lb ai/A per year. Limit 3 applications per year.
- spinosad (Success, Entrust SC) at 0.031 to 0.094 lb ai/A. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.28 lb ai/A per year. Limit 3 treatments per year. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Chinch bug

Blissus *spp.*

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

Chinch bugs cause damage to cultivated and uncultivated grasses through direct feeding. Removal of nutrients and obstruction of water transportation system causes the plant to become yellow and wilt. Initial injury occurs at or just below the soil level where the insect is most abundant. Economic losses very rare in healthy grain fields.

Chinch bug damage to cereals is most evident in May through July. Adults move from their overwintering sites in bunchgrasses to wheat and barley. The first generation chinch bug nymphs proceed to feed and develop on the cereal grains until these plants dry down. The nymphs then migrate to other suitable summer hosts.

Management—chemical control

Foliar sprays

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/A. PHI 0 days. REI 4 hr. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- *Chromobacterium subtsugae* (Grandevo WDG) at 0.6 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- gamma-cyhalothrin (Declare) at 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment inter-

val 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.

- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Cutworm and armyworm

Includes

Army cutworm (*Chorizagrotis auxiliaris*)
Black cutworm (*Agrotis ipsilon*)
Fall Armyworm (*Spodoptera frugipedra*)
Variegated cutworm (*Peridroma saucia* and *Euxoa* spp.)
Wheat head armyworm (*Faronta diffusa*)

Pest description and crop damage Young plants often are damaged in early spring. In recent years, growers in Washington and Idaho have made reports of these pests damaging barley and wheat crops. They feed on foliar tissue and can consume young seedlings to the ground. During the day, they hide in plant litter and/or just below the soil surface. Fall armyworm infestations in winter wheat have also been reported in south and southeastern Idaho in fall. There are no set thresholds and management recommendations depend on the stages of plant and larval development and the extent of the damage. More than 2-3 larger larvae (> 1/2in) per square foot may require control. Scout as many spots as possible within a field.

Management—chemical control

Foliar sprays

- alpha-cypermethrin (Fastac EC) at 0.008 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- azadirachtin (Aza-Direct, Ecozin 3EC) at 0.0125 to 0.043 lb ai/A. PHI 0 days. REI 4 hr. Best results can be obtained following 2 to 3 applications made at 7- to 10-day intervals. Some formulations are OMRI-listed for organic use.
- *Bacillus thuringiensis kurstaki* (Javelin) at 0.85 to 1.275 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.008 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- *Burkholderia* spp. (Venerate XC) at 1 to 4 quarts/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- chlorantraniliprole (Coragen) at 0.045 to 0.098 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai of chlorantraniliprole per acre per year. Limit 4 treatments. Armyworms only.
- *Chromobacterium subtsugae* (Grandevo WDG) at 0.3 to 0.9 lb ai/A. PHI 0 days. REI 4 hr. OMRI-listed for organic use.
- cyfluthrin (Tombstone) at 0.016 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.
- GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.17 to 0.34 lb ai/A. PHI 0 days. REI 4 hr. Do not exceed 5 applications or 1.7 lb ai/A per year. Must be tank mixed with *Bacillus thuringiensis* (*Bt*).
- lambda-cyhalothrin (Silencer, Warrior II) at 0.015 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.049 to 0.078 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments per year. Barley, oat, rye and wheat.
- methomyl (Lannate SP) at 0.225 to 0.45 lb ai/A. PHI 7 days. REI 48 hr. Do not exceed 1.8 lb ai/A per season. Do not exceed 4 applications per season. Wheat only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed.. Some formulations are OMRI-listed for organic use.
- spinetoram (Radiant SC) at 0.023 to 0.047 lb ai/A. PHI 21 days for grain and straw; 3 days for forage, fodder, or hay harvest. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.141 lb ai/A per year. Limit 3 applications per year.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.28 lb ai/A per year. Limit 3 treatments per year. Armyworms only. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.016 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Grass bug

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

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

Infestations of this insect occasionally occur in volunteer grain or grain growing under poor soil or moisture conditions. It has not been a common problem in grain-growing areas.

Management—chemical control

Foliar sprays

- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.022 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Grass sheathminer

Cerodontha dorsalis and *C. occidentalis*

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

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

Management—chemical control

Insecticides are not recommended.

Small grain—Grasshopper

Includes
Clear-winged grasshopper (*Camnula pellucida*)
Migratory grasshopper (*Melanoplus sanguinipes*)

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

Management—chemical control

Seed treatment

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

- imidacloprid (Gaucho 600F) at 1.2 to 2.4 fl oz per (0.047 to 0.094 lb ai) /100 lb seed to provide early-season protection. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr. To reduce early season damage caused by grasshoppers, Gaucho 600 treated seed may be planted as a 50 to 60 foot border around the edges of the field.
- thiamethoxam (Cruiser 5FS) at 1.33 fl oz (0.052 lb ai) /100 lb seed. REI 12 hr. Ground water advisory.

Foliar sprays

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/A. PHI 0 days. REI 4 hr. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- chlorantraniliprole (Coragen) at 0.026 to 0.065 lb ai/A. PHI 1 day. REI 4 hr. Retreatment interval 7 days. Do not exceed 0.2 lb ai of chlorantraniliprole per acre per year. Limit 4 treatments.
- cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- diflubenzuron (Dimilin 2L) at 0.015 to 0.031 lb ai/A. PHI for grain and straw 50 days; forage 3 days; hay 15 days. REI 12 hr. One treatment per season. Barley, oats, triticale, and wheat.
- dimethoate (Dimethoate 400) at 0.375 lb ai/A. PHI 35 days. REI 48 hr. Do not exceed 0.5 lb ai/A per season. Ground water advisory. Wheat only.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.

- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda-cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- malathion (Malathion 8) at 1.0 lb ai/A. PHI 7 days. REI 12 hr. Retreatment interval 7 days. Limit 2 treatments per year. Barley, oat, rye and wheat.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- spinosad (Success, Entrust SC) at 0.047 to 0.094 lb ai/A. PHI 21 days for grain and straw; 3 days for forage, fodder or hay. REI 4 hr. Retreatment interval 4 days. Do not exceed 0.28 lb ai/A per year. Limit 3 treatments per year. Entrust SC is OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Haanchen barley mealybug

Trionymus haancheni

Pest description and crop damage Adult females are small (0.2 inch long), elongate, oval, segmented insects often covered with white, waxy secretions that extend as filaments along the edges of the body. Nymphs resemble small adults. Eggs are laid in cottony sacs usually in the lower part of the plants and close to the soil surface. Adult males are the only winged form of the insect. All stages occur around the soil surface or under the leaf sheaths surrounding the stems. As plant start to mature, Haanchen barley mealybugs move higher up the stem to feed on the relatively more succulent tissues.

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

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

Management—chemical control

Insecticides are not currently registered for control of these pests.

Small grain—Harvester ant

Pogonomyrmex spp.

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

Management—chemical control

Insecticide control is not recommended

Small grain—Hessian fly

Mayetiola destructor

Pest description and crop damage Adult is a delicate, mosquito-like fly with a reddish brown to dusky black body. Adults do not cause any feeding damage, but they lay their eggs on the leaves within 2 to 4 days of emergence. The eggs hatch within 10 days and the larvae (maggots) start moving down the stem just beneath leaf-sheaths. When at or near the crown of the plant, they use their mouthparts to rasp the tissue and feed on the sap through the wound. Larval feeding stunts plants and reduces yield. Infested wheat seedlings can be darker than the healthy non-infested plants. Hessian fly is a threat to both fall spring seeded crops. Greatest damage is usually to wheat, but barley and rye also are attacked. Oats are resistant to this pest. Insects overwinter in puparial "flaxseed" stage in stubble, volunteer wheat, and fields seeded before mid-October.

Management—cultural control

Planting resistant cultivars is the most effective approach to minimize losses to this pest. Consult your crop advisor, extension educator, or specialist to select recommended varieties for planting in your region.

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

Management—chemical control

Seed treatments

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

- clothianidin (NipsIt Inside) at 1.79 fl oz (0.07 lb ai)/100 lb seed on-farm application. REI 12 hr. Do not exceed 0.2 lb ai/A clothianidin per year.
- imidacloprid (Gaucho 600F) at 0.8 to 2.4 fl oz (0.031 to 0.094 lb ai) per 100 lb seed. Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr.
- imidacloprid/metalaxyl/tebuconazole (GauchoXT) at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. REI 24 hr. Groundwater advisory: metalaxyl is known to leach through soil into groundwater under certain conditions as a result of agricultural use. Wheat, oats.
- thiamethoxam (Cruiser 5FS) at 0.75 to 1.33 fl oz (0.029 to 0.052 lb ai) per 100 lb seed. REI 12 hr. Ground water advisory.

Foliar sprays

- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season. Apply when adults emerge.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season. Apply when adults emerge.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda-cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Make applications when adults emerge. Groundwater advisory. Barley only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.

Small grain—Leafminer

Phytomyza nigra

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

Management—chemical control

Insecticide control is rarely needed.

Foliar sprays

- azadirachtin (Aza-Direct, Ecozin 3EC) at 0.0125 to 0.043 lb ai/A. PHI 0 day. REI 4 hr. Best results can be obtained following 2 to 3 applications made at 7- to 10-day intervals. Some formulations are OMRI-listed for organic use.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.

Small grain—Omnivorous leaftier

Cnephasia longana

Pest description and crop damage The larvae of leaftier moths are about 0.625 inch long when fully grown, with a tan head The body is yellowish or gray with a lighter stripe on each side of the back.

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

Management—chemical control

Damage rarely is enough to justify chemical control, except in the Willamette Valley of Oregon.

- *Bacillus thuringiensis kurstaki* (Javelin) at 0.85 to 1.275 lb ai/A. PHI 0 days. REI 4 hr.
- GS-omega/kappa-Hxtx-Hv1a (Spear Biological Insecticide) at 0.17 to 0.34 lb ai/A. PHI 0 days. REI 4 hr. Do not exceed 5 applications or 1.7 lb ai/A per year. Must be tank mixed with *Bacillus thuringiensis* (*Bt*).
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.

Small grain—Sawfly

Pachynematus spp.

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

Management—chemical control

Foliar sprays

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- gamma-cyhalothrin (Declare) at 0.0125 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.025 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.078 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.
- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda-cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Slug

Management—chemical control

- iron phosphate (Sluggo Maxx) at 0.1 to 0.46 lb ai/A. PHI 21 days for grain or straw, 3 days for forage, fodder or hay. Retreatment interval 4 days. Some formulations OMRI listed for organic use.
- liquid metaldehyde(slugfest) at 0.97 lb ai/A. Apply prior to formation of seed head. Retreatment interval 14 days. Limit 2 treatments per year. Wheat only.
- metaldehyde baits (Slug X) at 0.4 to1 lb ai/A. Retreatment interval 14 days. Wheat only.
- sodium ferric EDTA (Ferroxx) at 0.25 to 1 lb ai/A.

Small grain—Stink bug

Pest description and crop damage Green or brown shield-shaped true bugs, which use their piercing-sucking mouthparts to feed on foliar tissues including developing grain heads. They produce an unpleasant odor when disturbed, hence the name “stink bug”.

Management—chemical control

Foliar sprays

- alpha-cypermethrin (Fastac EC) at 0.02 to 0.025 lb ai/A. PHI 14 days for grain, forage and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.075 lb ai/A per season. Wheat and triticale.
- azadirachtin (Aza-Direct, Ecozin 3EC) at 0.0125 to 0.043 lb ai/A. PHI 0 day. REI 4 hr. Best results can be obtained following 2 to 3 applications made at 7- to 10-day intervals. Some formulations are OMRI-listed for organic use.
- *Beauveria bassiana* GHA (Mycotrol ESO) at 0.5 to 2 pints/A. PHI 0 days. REI 4 hr. Do not apply more than 6 pints/A. OMRI-listed for organic use.
- beta-cyfluthrin (Baythroid XL) at 0.014 to 0.019 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.038 lb ai/A per season.
- cyfluthrin (Tombstone) at 0.028 to 0.038 lb ai/A. PHI 30 days, 3 days for grazing or foraging. REI 12 hr. Retreatment interval 3 days. Do not exceed 0.076 lb ai/A per season of cyfluthrin alone, or the combined total of cyfluthrin plus beta-cyfluthrin. Wheat only.
- gamma-cyhalothrin (Declare) at 0.01 to 0.015 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.03 lb ai/A per season.
- lambda-cyhalothrin (Silencer, Warrior II) at 0.02 to 0.03 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.06 lb ai/A per season.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 0.059 to 0.098 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai lambda-cyhalothrin or 0.2 lb ai chlorantraniliprole per year.

- lambda-cyhalothrin/tebuconazole (Crossover) at 0.14 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Do not exceed 0.11 lb ai/A tebuconazole or 0.06 lb ai/A lambda-cyhalothrin per season. Do not exceed 8 fl oz/A or 0.139 lb ai/A per season. Barley, triticale and wheat.
- lambda-cyhalothrin/thiamethoxam (Endigo ZC) at 0.056 to 0.072 lb ai/A. PHI 30 days, 7 days for grazing or foraging. REI 24 hr. Retreatment interval 7 days. Do not exceed 0.06 lb ai/A lambda-cyhalothrin or 0.125 lb ai/A thiamethoxam per season. Groundwater advisory. Barley only.
- pyrethrin—There are several pesticides containing various amounts of pyrethrins. Check each label for the use and amount needed. Some formulations are OMRI-listed for organic use.
- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year.

Small grain—Wheat curl mite

Eriophyes tulipae

Pest description and crop damage Tiny eriophyid mite, cigar-shaped but not visible to the naked eye, which causes, leaf rolling along the edges, and proliferation of florets and distortion of wheat heads. The pest is a vector of *wheat streak mosaic virus (*WSMV), which can cause damage to small grains in some years. Late-planted spring and early-planted fall grains are susceptible to damage.

Management—cultural control

Mites require living host plants to survive. Control volunteer cereals and grassy weeds within and around fields, especially any fields with WSMV infection. This strategy is most effective when coordinated over a large area.

Management—chemical control

Chemical control is not available.

Small grain—Wheat jointworm

Harmolita tritici

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

Management—cultural control

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

Management—chemical control

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

Small grain—Wheat stem maggot

Meromyza pratorum and *Meromyza saltatrix*

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

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

Management—chemical control

Insecticides are not currently labeled for control of these pests.

Small grain—Wheat stem sawfly

Cephus cinctus

Pest description and crop damage Primarily a pest in Montana and southeastern Idaho. Adults are wasp-like black-and-yellow insects with smoky dark wings. They typically rest on wheat stems facing the ground. The larvae feeds inside the stem and through the process fill the hollowed stem with frass. This symptom is visible when stems are split open. The larva typically stays in an S-shaped position when removed from the stem. The larva overwinters in protective thin cover at the very base of the crown stubs. Lodging is the most visible damage by the larval feeding, which could result in considerable yield loss.

Management- cultural control

Tillage is expected to reduce the survival of the larvae as it would result in desiccation and interfere with overwintering. Barley, oat and rye can be planted as trap crops along the edges. While oat is a nonhost to the pest, wheat stem sawflies are unable to complete their development in barley and rye.

Solid stem wheat cultivars are effective in reducing losses to wheat stem sawflies. Consult your crop advisor, extension educator, or specialist to select recommended varieties for planting in your region.

Management—chemical control

Foliar sprays

- zeta-cypermethrin (Mustang) at 0.04 to 0.05 lb ai/A. PHI 14 days for grain, forage, and hay. REI 12 hr. Retreatment interval 14 days. Do not exceed 0.25 lb ai/A (0.125 lb ai/A for MustangMaxx) per year. Use for adults.

Small grain—Wheat strawworm

Harmolita grandis

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

Management—cultural control

This insect is throughout most of the Pacific Northwest but has not been a serious pest. Apparently, only wheat is damaged. Adults may lay eggs in barley, oats, and rye, but larvae can complete development only on wheat. Avoid growing wheat within 125 ft of wheat straw or stubble of previous season, because the spring form is wingless and does not migrate any distance. Thoroughly plowing under stubble and clean summer fallow reduce insect populations.

Management—chemical control

Chemical control is not recommended.

Small grain—Wireworm

Includes:
Sugar beet wireworm (*Limonius californicus*)
Western field wireworm (*Limonius infuscatus*)
Great Basin wireworm (*Selatosomus pruinina)*

Pest description and crop damage Wireworms are the larvae of click beetles. The adult beetles have elongated bodies with almost parallel lateral sides, and do not cause crop damage. Wireworms are the only damaging developmental stage. They are up to 0.75 inch long, yellowish or brownish, hard-bodied, and shiny. Wireworms burrow into planted seed, emerging sprout, or underground portions of the seedling. Wireworm feeding at the base of the seedling stem can result in wilting and death of the central leaf (a.k.a. “Deadheart”). Damage is more severe in cool, wet spring weather.

Management—chemical control

Wireworms are usually a localized problem. However, in recent years they resurged as significant pests of small grains in the PNW. Be sure to use seed treatments for wheat and barley. While wireworms can cause damage in both wheat and barley, studies have indicated that barley is relatively more tolerant of the damage. **Warning:** Treated seed must not be used for food or livestock feed. If a proprietary seed dressing is used, follow manufacturer’s directions.

Seed treatments

- broflanilide (Terraxa) at 0.26 oz/100 lbs seed (0.005lb ai/100lbs of seed). REI 12 hr. Do not apply more than 0.0445 lb ai/Acre per application and/or per year total, including seed treatment (when applicable) and soil application. Ground water advisory.
- clothianidin (NipsIt Inside) at 0.25 to 1.79 fl oz (0.01 to 0.07 lb ai)/100 lb seed on-farm application. REI 12 hr. Do not exceed 0.2 lb ai/A clothianidin per year.
- clothianidin/metalaxyl/metconazole (NipsIt Suite) at 5 to 7.5 fl oz (0.01 to 0.015 lb ai) /100 lb seed. REI 24 hr. Do not exceed 0.4 lb ai/A clothianidin per cropping cycle. Barley, oats, and wheat.
- imidacloprid (Gaucho 600F, Sativa IM RTU) at 0.13 to 0.26 fl oz/100 lb seed (0.005 to 0.01 lb ai). Do not graze or feed livestock on treated areas within 45 days after planting. REI 12 hr.
- imidacloprid/metalaxyl/tebuconazole (GauchoXT) at 3.4 to 4.5 fl oz (0.031 to 0.041 lb ai) /100 lb seed; early season protection. Do not graze or feed livestock on treated areas within 45 days after planting. REI 24 hr. Groundwater advisory: metalaxyl is known to leach through soil into groundwater under certain conditions as a result of agricultural use. Wheat, oats, barley.
- thiamethoxam (Cruiser 5 FS, Warden Cereals 360) at 0.19 to 0.25 fl oz (0.007 to 0.01 lb ai) per 100 lb seed. REI 12 hr. Ground water advisory.
- thiamethoxam/difenoconazole/mefenoxam/fludioxonil/sedaxane (Cruiser Vibrance Quattro) at 0.042 to 0.049 lb ai/100 lb seed. Do not graze or feed livestock on treated areas for 45 days after planting. REI 48 hr. Do not use at a rate that will result in more than 0.05 lb thiamethoxam per acre (22.7 grams ai/A) per year as a seed treatment application. Ground water advisory.

Sugar Beet Pests

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Latest revision—March 2024

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.

Refer to the insecticide tables for all chemical controls of sugar beet pests: at plant (Table 1), post emergence (Table 2), and biologicals, essential oils, etc. (Table 3).

Sugar beet—Aphid

Black bean aphid (*Aphis fabae*)
Green peach aphid (*Myzus persicae*)

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

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

Scouting and thresholds No formal economic thresholds exist for green peach aphid insecticide treatment decisions. If natural enemies are absent, consider an insecticide application if bean aphids are on most leaves and if colonies cover 20 to 40 percent of leaf surface. If natural enemies are present and aphid populations are relatively low, monitor closely to evaluate effectiveness of natural enemies before spraying.

Management—biological control

Aphids are attacked by a large variety of predatory and parasitic insects as well as by fungal diseases. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications. See Table 3 for commercially formulated biological products.

Management—chemical control

At-plant insecticides (Table 1) may only suppress aphids given that they usually occur late season when the level of active ingredients of at-plant products may have diminished. Pyrethroid (Group 3A) applications may make aphid management more difficult by eliminating aphid predators and parasitoids.

Sugar beet—Armyworm

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

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

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

Bertha armyworms are highly variable, from light yellow-green to gray-black, with a yellow-orange stripe along the side that divides the caterpillar

body into a dark upper half and a pale bottom half. They are about 1.25 inches long when mature.

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

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

Management—biological control

Armyworms commonly are attacked by parasitic wasps and flies that can help keep infestations in check. We do not yet know enough about arthropod natural enemies to suggest practical ways of manipulating and enhancing their effects other than avoiding any unnecessary insecticide applications. See Table 3 for commercially formulated biological products.

Management—chemical control

Only post-emergence options are available (Tables 2-3).

Sugar beet—Beet leafhopper

Circullifer tenellus

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

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

Management—cultural control

Manage curly top by planting approved resistant varieties rather than solely attempting to kill the highly mobile, winged adult. Protection of plants early during the season is most important; later during the season, age-related resistance can increase the plant's tolerance to curly top virus. Hot, dry spring weather will accelerate drying of non-cultivated plants on which beet leafhoppers overwinter and cause them to move to crops earlier during the season, increasing risk.

Management—biological control

Little is known about biological control of the beet leafhopper; some parasitoid wasps have been observed in Idaho, but at low levels. See Table 3 for commercially formulated biological products.

Management—chemical control.

Consider insecticide seed treatment (Table 1) in high-risk areas. Post-emergence treatments (Tables 2-3) may be used instead of or to supplement at-plant treatments, but application timing would have to coincide with movement of beet leafhoppers into fields. Extensive research in Idaho has demonstrated highest efficacy with group 4A and 3A products.

Sugar beet—Blister beetle

Epicauta spp. and others

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

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

Management—chemical control

Few insecticides are registered. See Tables 2-3.

Sugar beet—Carrion beetle

Silpha bituberosa

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

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

Management—cultural control

Prevent buildup by eliminating weedy host plants, including common lambsquarters and pigweed.

Management—chemical control

Very few insecticides are registered. See Table 2.

Sugar beet—Cutworm

Subterranean species include

Black cutworm (*Agrotis ipsilon*)
Glassy cutworm (*Apamea devastator*)
Redbacked cutworm (*Euxoa ochrogaster*)

Climbing species include

Army cutworm (*Euxoa auxiliaris*)
Spotted cutworm (*Xestia c-nigrum*)
Variegated cutworm (*Peridroma saucia*)

Pest description and crop damage Several species can cause significant damage to seedling-stage sugar beets, especially in fields where weedy spots or plant debris on the soil surface serve as sites for cutworm overwintering or early season egg laying. Cutworms generally are nocturnal, remaining by day just under the soil surface, so they are often not seen until after the plant already has been damaged.

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

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

Scouting and thresholds No formal economic thresholds exist for cutworm insecticide treatment decisions in sugar beets. Scouting at night and/or digging near damaged plants may be necessary to confirm presence of cutworms. Infestations typically are very spotty, usually occurring near weedy patches or along field borders. Consider spot treating infested sites rather than the entire field. Pheromone lures are available for some species that may be used to trap adults during autumn to predict risk of damage from larvae during the following spring.

Management—biological control

See Table 3 for commercially formulated biological products.

Management—chemical control

Numerous post-emergence insecticide options are available (Tables 2-3). Insecticide application during the evening may increase exposure of cutworms to insecticide during nighttime feeding. At-plant options are available as well (Table 1), but application decisions may have to be made before cutworm risk is known.

Sugar beet – False celery leaftier

Udea profundalis

Pest description and crop damage The common name derives from the caterpillar's habit of tying leaves together with silk, creating a shelter. Caterpillars are greenish and somewhat translucent with two pale stripes along a darker a light brown head capsule. Larvae skeletonize leaves and may become abundant in sugar beet fields during late season. Adult moths are reddish-brown to tan with several dark wavy lines on the wings as well as protruding mouthparts that appear as a "snout." Moths rest on the foliage of beets and/or weeds and will readily take flight when disturbed.

Scouting and thresholds No economic thresholds exist, and no insecticides are registered for use against the false celery leaftier in sugar beet.

Sugar beet—Flea beetle (adult)

Includes

Pale striped flea beetle (*Systena elongate*)
Three-spotted flea beetle (*Disconycha triangularis*)
Tuber flea beetle (*Epitrix tuberis*)
Western potato flea beetle (*E. subcrinita*)

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

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

Management—biological control

The insect-killing fungus, Beauveria bassiana, is available in commercial formulations.

Management—chemical control

Several insecticide options are available for flea beetles (Tables 1-3).

Sugar beet—Garden symphylan

Scutigerella immaculata

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

Scouting and thresholds No formal economic thresholds exist for symphylan insecticide treatment decisions. They occur in unpredictably spotty infestations and generally are considered minor pests.

Management—chemical control

Only one product is registered for at-plant application (Table 1), and only pyrethrin-containing products (Table 3) are available as "rescue" treatments that can be applied postemergence for symphylans in sugar beet.

Sugar beet—Grasshopper

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

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

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

Management—biological control

Beauveria bassiana-containing products are available in commercial formulations (Table 3).

Management—chemical control

Several post-emergence insecticides are available (Table 2).

Sugar beet—Leafminer

Beet leafminer (*Pegomya betae*)
Spinach leafminer (*Pegomya hyoscyami*)

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

Scouting and thresholds No formal economic thresholds exist for leafminer insecticide treatment decisions. If foliar sprays are used, they should be applied shortly after egg laying begins to reduce the number of larvae that are able to tunnel into leaves after hatching.

Management—biological control

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

Management—chemical control

Protect plants early season in high-risk areas with at-plant (Table 1) and/or post-emergence (Tables 1-2) insecticides. Extensive studies in Idaho have shown that seed treatment has similar efficacy to well-timed foliar-only treatments.

Sugar beet—Looper

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

Pest description and crop damage This is a minor leaf-feeding pest of sugar beets that is most commonly seen late in the season in sugar beets that border alfalfa fields. Mature larvae are up to 1.5 inches long and light to dark green with a thin white stripe along each side. Loopers differ from all other sugar beet caterpillars in that they have only three pairs of fleshy prolegs—on abdominal segments 5, 6, and 10—and crawl in a characteristic looping motion; all other sugar beet caterpillars have five pairs of prolegs—on abdominal segments 3, 4, 5, 6, and 10.

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

Management—biological control

Many microbial pathogen-derived products are available as commercial sprays (Table 3).

Management—chemical control

Many post-emergence insecticides are available (Tables 2-3).

Sugar beet—Lygus bug

Lygus spp.

Pest description and crop damage Pale green to red-brown sap-sucking bugs, 0.25 inch long when mature; the wings of adults fold flat over the back producing a yellowish, V-shaped mark behind the thorax. Lygus bugs are primarily seed feeders, so usually they are inconsequential pests except in sugar beet seed fields. Lygus bug damage may be observed as chlorosis and slight curling of the distal end of leaves; close inspection may reveal black "stings" from lygus bug feeding on the main leaf vein, just below where chlorosis begins.

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

Management—biological control

The insect-killing fungus, *Beauveria bassiana*, is available in commercial formulations.

Management—chemical control

Few conventional insecticide options are available as post-emergence sprays (Table 2), but several biorationale insecticides are registered (Table 3).

Sugar beet—Saltmarsh caterpillar

Estigmene acrea

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

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

Management—biological control

A few commercial formulations of insect-killing bacteria are available (Table 3).

Management—chemical control

Several post-emergence products are available (Tables 2-3).

Sugar beet—Spider mite

Tetranychus spp.

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

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

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

Management—biological control

Spider mites are often held in check by predators, especially predatory mites. Predators can be favored by limiting use of foliar insecticides and growing sugar beets under overhead irrigation where possible to reduce dust on foliage.

Management—chemical control

A few conventional insecticides and miticides are available (Table 2), but efficacy may be limited by possible chemical resistance and explosive population growth. Many biorationale products are available (Table 3), but also face limitations in relation to spider mite population growth.

Sugar beet—Stink bug

Pentatomidae

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

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

Management—biological control

A few biological products are available (Table 3).

Management—chemical control

Botanically and biologically based products are available (Table 3). No conventional insecticides are registered for stink bugs in sugar beet.

Sugar beet—Sugar beet crown borer

Hulstia undulatella

Pest description and crop damage Caterpillar is a dirty brown color with a green tint. Larvae feed on petioles at the plant crown and along the side of the taproot. They remain by day just below the soil surface within soil-coated silken tubes that extend 2 to 6 inches from infested plants. They are most damaging as first-generation larvae during May. This insect has historically been an important pest in the area, but not in recent years.

Management—biological control

Several species of parasitoid wasps and flies attack crown borers, but their importance in reducing populations is unclear. Limiting insecticide use should favor these natural enemies. No commercial formulations of biological control products are registered for this pest.

Management—chemical control

Few products are registered against the sugar beet crown borer in sugar beet (Tables 1-2).

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

Sugar beet—Sugar beet root aphid

Includes
Pemphigus betae
Pemphigus populivenae

Pest description and crop damage Pinhead-sized, pale white-yellow aphid that colonizes taproot. Aphids produce waxy white secretions that superficially resemble mold on beets.

Scouting and thresholds No formal economic thresholds exist for root aphid insecticide treatment decisions. Root aphids typically infest fields during late summer, which limits efficacy of at-plant insecticides.

Management—cultural control

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

Management—biological control

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

Management—chemical control

Chemical control is challenging given the cryptic habits of these soil insects. Some insecticides are registered for at-plant (Table 1) or post-emergence (Table 2) application. At-plant insecticide efficacy may be diminished by the time root aphids are present late season.

Note: For more information, see University of Idaho publication CIS 1176, Sugar Beet Root Aphids: Identification, Biology, & Management, https://www.extension.uidaho.edu/publishing/pdf/CIS/CIS1176.pdf.

Sugar beet—Sugar beet root maggot

Tetanops myopaeformis

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

Scouting and thresholds

For larval control

1. Use field history to determine the need for at-planting insecticides.
2. Determine the timing of postemergence insecticide applications by monitoring local flight activity of adult root maggots with orange-colored sticky traps. Control is most effective when insecticide application coincides with the time of peak seasonal fly capture on traps; earlier and especially later application is less effective. Total seasonal captures of 40 to 50 flies per trap through peak collection justify postemergence treatments. See University of Idaho publication BUL 942, *Sugar Beet Root Maggot: Identification, Biology, and Management*, https://www.extension.uidaho.edu/publishing/pdf/BUL/BUL942.pdf

For adult control

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

Management—chemical control

At-plant insecticides (Table 1) may be used where local pressure is consistently high, but post-emergence insecticides (Table 2) applied near peak flight will provide more reliable control. Extensive studies in Idaho have shown that aldicarb provides good control and terbufos does not. Seed treatment can be effective for moderate population levels. Other registered products are less well studied.

Sugar beet—Webworm

Alfalfa webworm (*L. cereralis*)
Beet webworm (*Loxostege sticticalis*)
Garden webworm (*Achyra rantalis*)

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

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

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

Management—biological control

Several biologically based insecticides are available for webworms (Table 3).

Management—chemical control

Several post-emergence insecticides are available for webworms (Table 2).

Sugar beet—White grub

Scarabaeidae

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

Infestations are most likely when sugar beets follow grassy pastures. Grasses are the preferred host plants both for oviposition and larval feeding. Some species require two or more years for egg-to-adult development, so old pasture can be infested with substantial populations of last-stage (large) grubs that are especially damaging to seedling sugar beet plants. White grubs are rarely a problem in sugar beet fields that do not follow grassy pastures.

Scouting and thresholds No formal economic thresholds exist for white grub insecticide treatment decisions. If following pasture with sugar beets, examination of soil for larvae before planting can inform the need for at-plant insecticides.

Management—biological control

Microbial biopesticides are available (Table 3).

Management—chemical control

Several at-plant and post-emergence insecticides are available (Tables 1-2).

Sugar beet—Wireworm

Sugar beet wireworm (*Limonius californicus*)
Pacific Coast wireworm (*Limonius canus*)

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

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

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

Management—chemical control

When chemical control is needed, at-plant insecticides (Table 1) are the preferred option given the potential for early season stand loss.

Table 1. Soil, seed, and in-furrow pesticides registered for insects and mites in sugar beet.

Active Ingredient	Trade Name	Aphids	Armyworm	Beet leafhopper	Blister beetle	Carrion Beetle	Cutworm	Flea beetle	Garden symphylan	Grasshopper	Leafminer	Looper	Lygus bug	Saltmarsh caterpillar	Spider mite	Stink bug	Sugar beet crown borer	Sugar beet root aphid	Sugar beet root maggot (larvae)	Sugar beet root maggot (adults)	Webworm	White grub	Wireworm	Insecticide Group	Signal Word	REI	PHI (days)
1,3-dichloropropene	Telone II (Dow)								X														X	8A	W	5 d	
aldicarb	AgLogic	X		X							X								X					1A	D	48 h	90-120*
alpha-cypermethrin	Fastac CS (BASF)						X												(X)			X	X	3A	C	12 h	50
clothianidin	NipsIt INSIDE (Valent), Lumisure (Corteva)	X		X			X	X			X								X				X	4A	C	12 h	
clothianidin/ *Bacillus firmus* I-1582	Poncho/Votivo (BASF)	X		X			X	X			X								X				X	4a	C	12 h	
clothianidin/beta-cyfluthrin	Poncho Beta	X		X			X	X			X								X				X	4A/3A	C	12 h	
esfenvalerate	Asana XL (Valent), Zyrate (Rotam), others						X																	3A	W	12 h	21
imidacloprid	Advise Four (Winfield), Attendant 480 FS (UPL), Gaucho 600 (Bayer), others	X		X				X										X					X	4A	C	12 h	0
phorate	Thimet 20G Smartbox and Thimet Lock N' Load (AMVAC)	X		X							X				X				X					1B	D	48 h	30

terbufos	Counter 20G Smartbox and Counter 20G Lock N' Load (AMVAC)	X		X			(X)										X		X			X	X	1B	D	48 h	90-150 *
thiamethoxam	Cruiser 5FS (Syngenta)			X							X							X	X			X	X	4A	C	12 h	
zeta-cypermethrin	Mustang and Mustang MAXX (FMC)						X												(X)			X	X	3A		12 h	50

All trade names may not be listed. The products that are listed are not in order of efficacy or preference. Always refer to the specific product label before making recommendations and/or applications.

X = labelled for control; (X) = labelled for suppression; * = range of number of days depends on application method.

Abbreviations: C = Caution; W = Warning; D = Danger. PHI = Pre-harvest interval. REI = Restricted entry interval.

Table 2. Conventional post-emergence pesticides registered for insects and mites in sugar beet.

Active Ingredient	Trade Name	Aphids	Armyworm	Beet leafhopper	Blister beetle	Carrion Beetle	Cutworm	Flea beetle	Garden symphylan	Grasshopper	Leafminer	Looper	Lygus bug	Saltmarsh caterpillar	Spider mite	Stink bug	Sugar beet crown borer	Sugar beet root aphid	Sugar beet root maggot (larvae)	Sugar beet root maggot (adults)	Webworm	White grub	Wireworm	Insecticide Group	Signal Word	REI	PHI (d)
aldicarb	AgLogic	X		X							X								X					1A	D	48 h	90-120*
alpha-cypermethrin	Fastac CS (BASF)	X	X				X	X		X	X	X								X				3A	C	12 h	50
alpha-cypermethrin	Fastac EC (BASF)						X	X		X														3A	D	12 h	50
carbaryl	Carbaryl 4L (Drexel), Sevin XLR Plus (NovaSource), others		X	X			X	X													X			1A	C	12 h	28
chlorantraniliprole	Vantacor (FMC)		X							X														28	W	4 h	1
esfenvalerate	Asana XL (Valent), Zyrate (Rotam), others		X	X			X	X		X		X		X						X	X			3A	W	12 h	21
etoxazole	Zeal (Valent)														X									10B	C	12 h	30
hexythiazox	Onager Gowan), Ruger 1EC (Atticus)														X									10A	C	12 h	45
methomyl	Annihilate LV (MacDermit), Lannate	X	X			X	X	X													X			1A	D	48 h	21-30*

	LV and Lannate SP (DuPont), others																										
methoxyfenozide	Inspirato 2F (Atticus), Zylo (UPL), others		X				(X)					X		X							X			18	C	4 h	7
methoxyfenozide/ spinetoram	Intrepid Edge (Corteva)		X				(X)					X		X							X			18/5	C	4 h	7
naled	Dibrom 8 Emulsive (AMVAC)	X	X	X						X			X		X					X				1B	D	48 h	2
phorate	Thimet 20G Smartbox and Thimet Lock N' Load (AMVAC)	X													X				X					1B	D	48 h	30
spinosad	Blackhawk (Corteva)		X								X	X												5	C	4 h	3
spinetoram	Delegate WG and Radiant SC (Corteva)		X					(X)			X	X												5	C	4 h	7
spirotetramat	Movento (Bayer)	X																X	(X)					23	C	24 h	28
spirotetramat/pyriproxyfen	Senstar (Valent)	X																X	(X)					23/7C	C	24 h	28
sulfoxaflor	Transform WG (Corteva)	X		X																				4C	D	24 h	7
terbufos	Counter 20G Smartbox and Counter 20G Lock N' Load (AMVAC)	X		X													X	X	X					1B	D	48 h	90-150*
triphenyltin-hydroxide	Agri Tin		(X)																					.	D	48 h	21

	(Nufarm)																										
zeta-cypermethrin	Mustang and Mustang MAXX (FMC)	X	X	X	X		X	X		X	X	X	X				X			X	X			3A	W	12 h	50

All trade names may not be listed. The products that are listed are not in order of efficacy or preference. Always refer to the specific product label before making recommendations and/or applications.

X = labelled for control; (X) = labelled for suppression; * = range of number of days depends on application method.

Abbreviations: C = Caution; W = Warning; D = Danger. PHI = Pre-harvest interval. REI = Restricted entry interval.

Table 3. Biologicals, essential oils, and other biorationale pesticides registered for insects and mites in sugar beet.

Active Ingredient	Trade Name	Aphids	Armyworm	Beet leafhopper	Blister beetle	Carrion Beetle	Cutworm	Flea beetle	Garden symphylan	Grasshopper	Leafminer	Looper	Lygus bug	Saltmarsh caterpillar	Spider mite	Stink bug	Sugar beet crown borer	Sugar beet root aphid	Sugar beet root maggot (larvae)	Sugar beet root maggot (adults)	Webworm	White grub	Wireworm	Insecticide Group	Signal Word	REI	PHI (d)	OMRI
azadirachtin	Aza-Direct (Gowan), others	X	X	X			X	X			X	X	X	X	X	X								UN	C	4 h		x
azadirachtin	Azatin-O (OHP), others	X	X	X	X		X	X		X	X	X	X	X		X					X		X	UN	C	4 h		x
Bacillus thuringiensis aizawai	Agree WG (Certis)		X									X												11 A	C	4 h	0	x
Bacillus thuringiensis aizawai	XenTari (Valent)		X				X					X		X							X			11 A	C	4 h		x
Bacillus thuringiensis kurstaki	BioBit HP (Valent), Crymax (Certis), others		X				X					X		X							X			11 A	C	4 h	0	x
Beauveria bassiana	BotaniGard 22 WP and BotaniGard ES (Certis), Mycotrol ESO and WPO (Certis), others	X	X	X				X		X		X	X		X	X		X				X	X	UN F	C	4 h	0	x
Burkholderia spp	Venerate CG	X	X	X			X					X	X	X	X	X		X	X		X	X	X	UN B	C	4 h	0	x

	(Marrone Bio)																											
Burkholderia spp	Venerate XC (Marrone Bio)	X	X									X												UNB	C	4 h	0	x
canola oil/garlic oil/capsicum oleoresin extract	Captiva Prime (Gowan)		X												X										C	4 h	0	x
Chromobacterium subtsugae	Grandevo CG and Grandevo WDG (Marrone Bio)	X	X									X													C	4 h	0	x
garlic oil	Garlic Barrier AG+		(X)	(X)					(X)	(X)	(X)				(X)							(X)	(X)					x
GS-omega/kappa-Hxtx-Hv1a	Spear LEP (Vestaron)		X				X					X		X							X			32	C	4 h	0	
kaolin	Surround WP (NovaSource), others		(X)	(X)			(X)	(X)		(X)					(X)											C	4 h		x
mineral oil	JMS Stylet-Oil (JMS), Purespray green (Intelligro), others	X	X	X							X				X										C	4 h		x
neem oil	Ecoworks EC (Ecostadt), others	X	X				X	X			X	X	X		X	X									C	4 h		x
potassium salts of fatty acids	M-Pede (Gowan), others	X		X							X				X										W	12 h	0	x
potassium silicate	Sil-Matrix LC (Certis)	X													X										C	4 h	0	x
pyrethrins	Tersus (MGK), various	X	X	X	X			X	X	X	X	X	X	X		X					X			3A	C	12 h	0	

	others																											
pyrethrins/azadirachtin	Azera, Azera Pro (Valent)	X	X	X	X		X	X	X	X	X	X	X	X	X	X					X		X	3A	W	12 h		x
pyrethrins/Beauveria bassiana	BotaniGard MAXX (Certis)	X	X	X				X		X		X	X		X	X					X	X		3A	W	12 h	after spray has dried	
pyrethrins/ piperonyl butoxide	Evergreen Pro 60-6 (MGK)	X	X	X	X			X		X		X	X			X					X			3A	C	12 h	after spray has dried	
sodium tetraborohydrate decahydrate	Prev-Am (Oro Agri)	X	X	X								X												8D	W	24 h		
soybean oil / garlic oil / capsicum oleoresin extract	Captiva (Gowan)		X	X											X										C	4 h	0	x
spinosad	Entrust and Entrust SC (Corteva)		X								X	X												5	C	4 h	3	x
Spodoptera exigua multinucleopolyhedrovirus (SeMNPV)	Spexit (Andermatt Biocontrol)		X																						C	4 h	0	x
sulfur	Sulfur 80 WDG (Drexel), others														X									UN	C	24 h	0	x

All trade names may not be listed. The products that are listed are not in order of efficacy or preference. Always refer to the specific product label before making recommendations and/or applications.

X = labelled for control; (X) = labelled for suppression; * = range of number of days depends on application method.

Abbreviations: C = Caution; W = Warning; D = Danger. PHI = Pre-harvest interval. REI = Restricted entry interval.

Sunflower Pests

Timothy Waters

Latest revision—March 2024

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

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

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

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

Sunflower—Banded sunflower moth

Cochylis hospes

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

Management—cultural and biological control

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

Management—chemical control

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

- *Bacillus thuringiensis* (*Bt*) (several brands)—Consult label for rate. PHI 0 days. Some formulations are OMRI-listed for organic use.
- chlorantraniliprole (Prevathon) at 8 to 20 fl oz/A. Do not apply more than 0.2 lb ai/A of chlorantraniliprole per season. PHI 21 days. REI 4 hr.
- cyanatraniliprole (Exirel) at 7 to 13.5 fl oz/A. Do not apply more than 0.4 lb ai/A of cyantraniliprole per season. PHI 7 days. REI 12 hr.
- deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/A. Do not apply more than 0.045 lb ai/A per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. Do not exceed 0.2 lb ai/A per season. PHI 28 days. REI 12 hr.
- gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/A. Do not apply more than 0.06 lb ai/A or more than 0.045 lb ai/A after bloom begins. Less product is allowed if other cyhalothrin pesticides are used; see label. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Cutworm

Includes
Darksided cutworm (*Euxoa messoria*)
Dingy cutworm (*Feltia jaculifera*)
Redbacked cutworm (*Euxoa ochrogaster*)

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

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

Management—chemical control

- beta-cyfluthrin (Baythroid XL) at 0.007 to 0.013 lb ai/A. A maximum of 0.22 lb ai/A per 7 days or 0.066 lb ai/A per season. PHI (pre-grazing and pre-foraging) 30 days. REI 12 hr.
- carbaryl (Sevin) at 1 to 1.5 lb ai/A. PHI 60 days. REI 24 hr.
- deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/A. Do not apply more than 0.045 lb ai/A per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.02 to 0.05 lb ai/A. A total of 0.132 lb ai/A may be applied per season. PHI 28 days. REI 12 hr.
- gamma-cyhalothrin (Proaxis) at 0.0075 to 0.0125 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 5 to 8 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Grasshopper

Several species

Management—chemical control

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

Sunflower—Seed weevil

Includes
Gray seed weevil (*Smicronyx sordidus*)
Red sunflower seed weevil (*Smicronyx fulvus*)

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

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

Management—chemical control

- beta-cyfluthrin (Baythroid XL) at 0.016 to 0.022 lb ai/A. A maximum of 0.22 lb ai/A per 7 days or 0.066 lb ai/A per season. PHI (pre-grazing and pre-foraging) 30 days. REI 12 hr.
- cyanatraniliprole (Exirel) at 10 to 20.5 fl oz/A. Do not apply more than 0.4 lb ai/A of cyantraniliprole per season. PHI 7 days. REI 12 hr.
- deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/A. Do not apply more than 0.045 lb ai/A per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. Do not exceed 0.2 lb ai/A per season. PHI 28 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Stem weevil

Black sunflower stem weevil (*Apion occidentale*)
Sunflower stem weevil (*Cylindrocopturus adspersus*)

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

Management—chemical control

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

Sunflower—Sunflower beetle

Zygogramma exclamationis

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

Management—chemical control

- carbaryl (numerous formulations of Sevin) at 1 to 1.5 lb ai/A. Do not apply within 30 days of grazing or harvest for forage. PHI 60 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.015 to 0.03 lb ai/A. Do not exceed 0.2 lb ai/A per season. PHI 28 days. REI 12 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 5 to 8 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Sunflower maggot

Gymnocarena diffusa

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

Management—chemical control

- deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/A. Do not apply more than 0.045 lb ai/A per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. Repeat as necessary for control. Do not exceed 0.2 lb ai/A per season. PHI 28 days. REI 12 hr.
- gamma-cyhalothrin (Proaxis) at 0.01 to 0.15 lb ai/A. Do not apply more than 0.06 lb ai/A or more than 0.045 lb ai/A after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.

- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr. (Adult only)

Sunflower—Sunflower moth

Homoeosoma electellum

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

Economic threshold Chemical control is recommended at one to two adults per five plants at the onset of bloom or within 7 days of the adult moth's first appearance. Fields in bloom or that bloom 2 weeks or more after the first adult moth appearance have very low potential for damage despite the presence of moths in threshold numbers. Pheromone traps are available to scout for this pest.

Management—chemical control

- *Bacillus thuringiensis* (*Bt*) (several brands)—Consult label for rate. PHI 0 days. Some formulations are OMRI-listed for organic use.
- carbaryl (Sevin) at 1.0 to 1.5 lb ai/A. PHI 60 days. REI 24 hr.
- chlorantraniliprole (Prevathon) at 8 to 20 fl oz/A. Do not apply more than 0.2 lb ai/A of chlorantraniliprole per season. PHI 21 days. REI 4 hr.
- cyanatraniliprole (Exirel) at 7 to 13.5 fl oz/A. Do not apply more than 0.4 lb ai/A of cyantraniliprole per season. PHI 7 days. REI 12 hr.
- deltamethrin (Delta Gold 1.5 EC) at 0.012 to 0.018 lb ai/A. Do not apply more than 0.045 lb ai/A per season. Do not graze or feed treated foliage to livestock. PHI 21 days. REI 12 hr.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. Do not exceed 0.2 lb ai/A per season. REI 12 hr. PHI 28 days.
- gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/A. Do not apply more than 0.06 lb ai/A or more than 0.045 lb ai/A after bloom begins. Less product is allowed if other cyfluthrin compounds are used; see label. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

Sunflower—Woolly bear caterpillar (Isabella tiger moth)

Black banded woolly bear (*Pyrrhactica isabella*)

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

Management—chemical control

- carbaryl (Sevin) at 1 to 1.5 lb ai/A. PHI 60 days. REI 24 hr.
- esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/A. Do not exceed 0.2 lb ai/A per season. PHI 28 days. REI 12 hr.
- lambda-cyhalothrin (Warrior II) at 0.02 to 0.03 lb ai/A. Do not apply more than 0.12 lb ai/A per season or more than 0.09 lb ai/A after bloom begins. PHI 45 days. REI 24 hr.
- lambda-cyhalothrin/chlorantraniliprole (Besiege) at 6 to 10 fl oz/A. Do not apply more than 0.12 lb ai/A per season of lambda-cyhalothrin or more than 0.2 lb ai/A of chlorantraniliprole. PHI 45 days. REI 24 hr.

For more information:

Knodel, J., Charlet, L., and Gavloski, J. Integrated Pest Management of Sunflower Insect Pests In the Northern Great Plains. 2015. North Dakota State University Extension Service. E- 1457. https://www.ag.ndsu.edu/publications/crops/integrated-pest-management-of-sunflower-insect-pests-in-the-northern-great-plains/e1457.pdf

Sloderbeck, P., Assefa, G., Michaud, J., Peiars, F., and Hein, G. Insect Pest Identification and Control. 2009. In: High Plains Sunflower Production Handbook. Kansas State University. MF-2384. https://www.bookstore.ksre.ksu.edu/pubs/MF2384.pdf

Hemp Pests

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Latest revision—March 2024

INCLUDES MANAGEMENT OPTIONS FOR COMMERCIAL 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.

There are limited chemical options for the control of pests in hemp. It is essential to consult pesticide labels for rates, timings, safety precautions, plant-back restrictions, etc. prior to making a recommendation or deciding on a treatment program. There are web resources available to search for labeled pesticides and to see specimen labels of products. One source can be found at https://picol.cahnrs.wsu.edu/ which is a database of all pesticides registered in Washington and Oregon. Copies of almost all pesticide labels can be found through the following sites.

http://www.cdms.net/Label-Database

http://www.agrian.com/home/label-lookup/overview

In addition, these companies offer searchable databases of products and which pests and crops are on their labels. These web resources allow thorough research on pesticide products prior to making recommendations or treatment decisions.

For general information on hemp:

https://www.oregon.gov/oda/programs/hemp/pages/abouthemp.aspx

Hemp—Aphids

Includes:
Cannabis aphid/hemp aphid/bhang aphid (*Phorodon cannabis*)
Green peach aphid (*Myzus persicae*)
Potato aphid (*Macrosiphum euphorbiae)*
Rice root aphid (*Rhopalosiphum rufiabdominale*)

Pest description and crop damage Several aphid species (Order: Hemiptera; Family: Aphididae) can be found in hemp in the PNW. Aphids are soft-bodied insects with a pair of abdominal cornicles that exude pheromones or defensive secretions. The most common aphid species associated with indoor and outdoor grown hemp plants include green peach aphids, potato aphids, rice root aphids and cannabis aphids. In general, green peach aphids are pale or dark green in color; potato aphids are pink and green in color; cannabis aphids are light green, pale pink and light brown in color; and rice root aphids are olive-red in color. However, aphid species identification based on the color alone is often not accurate. All these aphids can be recognized by observing the antennal tubercles under a stereo microscope: convergent tubercles on green peach aphids; upward sloped tubercles on potato aphids; horn-like projections on cannabis aphids; and no clearly visible tubercles on rice root aphids.

Among these, cannabis aphids and rice root aphids are the most damaging aphids, usually under indoor hemp production systems. The cannabis aphid is found on the leaves, stems and flower buds of hemp plants, while the rice root aphid is found below ground and at the base of the plant. In outdoor production, aphids are generally controlled by natural enemies. Cannabis aphids can be found both in indoor and outdoor hemp production systems; but, so far, rice root aphids have not been found in outdoor production in the PNW.

Biology and life history Potato aphid and green peach aphid have broad host ranges, and they feed on many crops, weeds, and native plants. In contrast, the cannabis aphid is a specialist herbivore, and it feeds only on hemp plants. Potato aphid and green peach aphid winged adults arrive on hemp from weeds and various host crops where they overwintered as eggs, nymphs and adults. Both aphid species are usually found to colonize the hemp plants during spring season. So far, it is not clear how cannabis aphids are transported to outdoor hemp plants, but it is likely that adults move from greenhouse transplants or from volunteer field plants, and high populations are present on hemp plants during summer and fall seasons. Throughout the growing season, all aphids produce live young, all of which are female and can be either winged or wingless. Winged aphids tend to be produced more often when the aphid population becomes crowded. In the fall, when winged males (potato aphids or green peach aphids) are produced, they fly to overwintering hosts and mate with egg-laying females produced on that host. In the case of cannabis aphids, eggs, which are initially yellow-green and then turn black,

are laid on the hemp leaves surrounding the bud. These eggs can remain dormant through the winter and hatch in the spring. All species may undergo multiple overlapping generations per year.

Scouting and thresholds Plants should be checked for aphids at least weekly starting shortly after emergence. When plants are upright, the most effective scouting method is to shake plants above beating sheets, beating trays, or white half-gallon ice cream buckets. This sampling method will evaluate the presence of aphids at a single point in time. In some hemp varieties, the shoots become very long and bushy and become intertwined, making scouting difficult. In this case, sampling and inspecting individual leaves could be useful. Another method that can be helpful to determine the aphid presence on hemp plants is to install the yellow sticky traps at the field edges for outdoor production or hang the traps near the plants for greenhouse production. Traps should be monitored at weekly intervals. Currently, there are no established treatment thresholds for aphids that warrant insecticide application. However, monitoring of aphids can help to develop a pest management program.

Management—biological control

In outdoor production, hemp harbor large numbers of generalist predators that can prey on aphids feeding on hemp plants. These include the hemipteran bugs: minute pirate bug (*Orius* spp.), big-eyed bug (*Geocoris* spp.) and damsel bug (*Nabis* spp.). Other common aphid predators include lady beetles and their larvae, lacewings, and syrphid (or flower fly) larvae. Aphid-specific parasitoid wasps (*Aphidius* spp. and *Aphelinus* spp.) may also present on hemp fields. However, the role of natural biological control agents in suppressing the aphid population in hemp has not been explored in the PNW. For indoor production, several commercially available biological control agents (such as *Aphidius colemani* for green peach aphids, *Aphidius matricaria* for cannabis aphids) can be used to manage aphid populations.

Management—cultural control

Purchase transplants from reliable sources.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Caterpillars

Includes:
Corn earworm (*Helicoverpa zea*)
False corn earworm (*Heliothis phloxiphaga*)
Bertha armyworm (*Mamestra configurata*)
Tobacco budworm (*Heliothis virescens*)
Spotted cutworm (*Xestra c-nigrum*)
Alfalfa looper (*Autographa californica)*
Cabbage looper (*Trichoplusia ni)*

Pest description and crop damage Several moth caterpillar species (Order: Lepidoptera; Family: Noctuidae) can be found in hemp in the PNW. All these caterpillars or larvae have three pair of true legs behind their head. The corn earworm, tobacco budworm, bertha armyworm, and spotted cutworm are varied in color, but all have five pair of pro-legs towards the rear end, while the larvae of both looper species appear as green caterpillars with white longitudinal stripes and have just three pair of pro-legs at the rear end. Loopers move in a looping fashion, like an inchworm.

The corn earworm is the most damaging of these caterpillars as it feeds on the floral parts (mainly flower buds) of hemp plants. Also, corn earworm caterpillars sometimes nestle within flower bud materials, making it harder to scout for them on plants. Corn earworm feeding on flower buds creates extensive bud tunneling and wounds, allowing pathogens to invade that can aid development and presence of bud rot. Loopers chew holes and ragged edges in hemp leaves. Damage to mature hemp plants from caterpillars, other than corn earworm, is usually minor and does not require control. However, false corn earworm caterpillars are recently found to feed on hemp flower buds in southern Oregon, and the level of damage that this pest can cause needs further investigation.

Biology and life history Corn earworm adult moths are nocturnal. Females deposit eggs singly on hemp leaves and flower buds. Based on the available information from other crops, each female may lay up to 1,500 eggs in her lifetime, and each female may lay up to 35 eggs per day. Eggs hatch within 2 to 4 days, and newly emerged caterpillars start to feed on hemp plants, usually found feeding on flower buds. Young caterpillars (first and second instars) are small (about 2 mm in length), but they grow quickly and are fully developed (fifth and sixth instars) within 2-3 weeks. The mature caterpillars are about 25 mm in length. Corn earworm caterpillars are highly varied in color, ranging from pink, green, pale brown to almost black; however, matured caterpillars are mainly green in color when found in hemp. Mature caterpillars leave the feeding site, drop to the ground, burrow into the soil and become pupae. In summer, adults emerge in approximately 2 weeks and produce a new generation. However, in the fall/autumn, the pupae remain dormant until the following season.

Scouting and thresholds Heliothis traps baited with corn earworm pheromone lures can be used to monitor the corn earworm moth population in hemp during flowering stage. The traps should be placed at the edge of hemp fields, usually one trap per field. It is also critical to scout hemp fields for eggs and caterpillars feeding on flower buds to determine the proper treatment timing. At this point, there are no established treatment thresholds for corn earworm in hemp.

Management—biological control

Generalist predators such as big-eyed bugs, damsel bugs and lady beetles can prey on corn earworm eggs and caterpillars. Also, corn earworm eggs can be parasitized by *Trichogramma* spp. and caterpillars by *Archytas marmoratus* and *Microplitis croceipes*. However, the role of these biological control agents in controlling corn earworm on hemp has not been fully investigated.

Management—cultural control

The effect of cultural practices (such as varietal selection, crop rotation and planting date) on corn earworm management should be explored as there is currently limited information available.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

Pest description and crop damage The Western spotted cucumber beetle (Order: Coleoptera; Family: Chrysomelidae) is yellowish green and 0.25-inch-long, and has 11 black spots on its wing covers. Adult cucumber beetles eat small holes in the leaves and flowers of many crops. They are commonly found feeding on hemp. Damage to mature hemp plants is usually minor and does not require control. No scouting or thresholds are needed since this is a minor pest on hemp. See Common Pests of Vegetable Crops for more information.

Hemp—Grasshoppers

Includes:
Spotted winged grasshopper (*Orphulella pelidna*) and others

Pest description and crop damage Many different grasshopper species (Order: Orthoptera; Family: Acrididae) live in areas near or where hemp is grown, especially in eastern and southern Oregon.

See also:
Hay and Pasture Crops

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Leafhoppers

Includes:
Beet leafhopper (*Circulifer tenellus*)
Other leafhoppers (*Empoasca* spp., *Ceratagallia* spp., *Macrosteles quadrilineatus*)

Pest description and crop damage The most important leafhopper pest for hemp producers in the PNW is the beet leafhopper (Order: Hemiptera; Family: Cicadellidae) mainly due to its ability to transmit the beet curly top virus. To learn more about the epidemiology and symptoms of beet curly top virus on hemp, check out this information (https://pnwhandbooks.org/plantdisease/host-disease/hemp-cannabis-sativa-curly-top) from the *Pacific Northwest Plant Disease Management Handbook*. This leafhopper varies between 0.13 to 0.14 inches in size, and within different shades of yellow in color. It can be recognized from other similar leafhopper for the absence of head markings. See Potato, Irish chapter for more details. In addition, a wide diversity of other leafhoppers (e.g., *Empoasca* spp., *Ceratagallia* spp., and *M. quadrilineatus)* can be found in hemp fields. These leafhoppers are small, pale green, and torpedo-shaped. However, their ecological roles in hemp are unknown.

Biology and life history Beet leafhopper can feed and reproduce in many wild hosts (e.g., kochia, Russian thistle, tumble mustard, pigweed, lambsquarters, and groundsel) and crop hosts (sugar beet, potato, carrot, tomato, and cucurbits). In early spring, the beet leafhopper adults move into crop fields from overwintering sites to search for suitable hosts. Females deposit whitish to yellow colored elongated and slightly curved single eggs in the tissue of the leaves and stems. Under optimal conditions, each female can lay 300–400 eggs in their life cycle. Young leafhoppers (nymphs) are transparent to white but become yellowish within a few hours; later they can show black, red, and brown spots on the body. Both nymphs and adults show high mobility and jump away when disturbed. In Oregon and Washington, the leafhopper generally completes three generations per year.

Scouting and thresholds Monitoring of beet leafhoppers is recommended to evaluate population dynamics. An efficient method to monitor is by using yellow sticky cards placed on the edge of the field. As other species of leafhopper are regularly present in hemp fields, it is important to correctly identify the beet leafhopper.

Management—biological control

Beet leafhoppers and other leafhoppers are preyed on by generalist predators such as green lacewings, spiders, assassin bugs, and big-eyed bug, and can be parasitized by several wasp belonging to the families of Mymaridae and Trichogrammatidae, and flies belonging to the family Pipunculidae.

Management—cultural control

Managing the favorite weed hosts (e.g., kochia, Russian thistle and tumble mustard) of beet leafhopper is probably the most important cultural management option although sometimes unpractical.

Management—chemical control:

See:

Pesticide Table for Hemp Pests

Hemp—Lygus bug

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

Pest description and crop damage Lygus bugs (Order: Hemiptera; Family: Miridae) are found on many field crops throughout PNW. *Lygus hesperus* and *L. elisus* are the most common species of lygus bugs in the PNW. In general, lygus bug adults are 4.4 to 6.3 mm long and 2.1 to 2.8 mm wide. Their body is marked with a V-shaped or triangular mark on the back (scutellum). Color ranges from light green to shades of brown or black. Nymphs are 0.04 to 0.25 inch in length, green or yellow-green, with black spots on the back. In the PWN, lygus bugs can occur on hemp plants throughout the growing season, but higher numbers can be found on late July to mid-August, coinciding with hemp flowering stage. Currently, it is unknown whether lygus bugs can cause economic damage to hemp plants.

Biology and life history *Lygus* species feed on many different plants including weeds, crops, and native species. Alfalfa and quinoa fields often develop very large populations of lygus from which the insects may colonize hemp. Lygus can be found throughout the growing season and are common all over the PNW. They usually complete three or four generations each year.

Scouting and thresholds Lygus are easily found during normal scouting operations using a beating sheet/tray technique or with a vacuum sampler (i.e., inverted leaf blower) or by observing insect activity while walking through the crop. Both adults and nymphs of all sizes are likely to be present at the same time. There are no established treatment thresholds for lygus in hemp.

Management—biological control

Generalist predators such as big-eyed bugs, lady beetles and damsel bugs, are known to prey on lygus adults and nymphs. There are also braconid wasp parasitoids attacking lygus in the PNW.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Mite (Russet)

Hemp russet mite (*Aculops cannibicola*)

Pest description and crop damage Hemp russet mites (Order: Acari; Family: Eriophyidae) were first discovered in Europe in 1960 and they are currently known to be present in different regions of the US including the PNW. These mites are extremely small and can only be seen with a microscope and not with the naked eye. Similar to other eriophyid mites, they have an elongated body and are pale in color. Hemp russet mites' range in size from 160 to 210 microns or less than the half the size of two-spotted spider mites; they have only two pairs of legs; and females are typically larger in size than males.

Hemp russet mites are one of the most damaging pests for hemp plants grown under greenhouse conditions. There is no confirmed report of infestation to outdoor grown hemp in Oregon or in the PNW, but they have been reported in outdoor conditions in other states such as Colorado, Utah and Virginia. These mites feed on fluids from the outer plant surface cells on leaves, petioles and shoot tips. Compared with other mite species such as two-spotted spider mites, they do not produce webbing on plants and their damage is often unnoticed in low populations. When there is a heavy infestation, leaf damage symptoms apparent on hemp plants include upward curling along leaf edges, russeting leaf tissue, and brown or powdery appearance on leaf edges. Feeding symptoms on the petioles consist of slight bronzing or a golden color. Severe infestations on developing flower buds can reduce bud growth and size that will eventually impact yield and quality.

Biology and life history The hemp russet mite biology and life history have not been well-studied, but they are believed to be similar to tomato russet mite. The life cycle can be completed very rapidly (7-10 days) under optimal conditions. These mites most likely survive year-round on hemp plants in the greenhouse environment. However, it is not clear yet how hemp russet mites survive among plants in the field since hemp is the only known host for this mite species.

Scouting and thresholds Regular scouting of plants is required. Since mites are not visible to the naked eye and the symptoms may resemble disease and/or abiotic stress, it is recommended to collect leaves and check for russet mites under a microscope to verify infestation. Also, the mite brushing technique can be used to check the infestation level. There are no established treatment thresholds for hemp russet mite.

Management—biological control

No research information is available on which biological agents are effective against hemp russet mites. The generalist predator, *Amblyseius swirskii,* may have some potential to control hemp russet mites; this agent has been shown to control tomato russet mites which belong to the same genus as the hemp russet mite.

Management—cultural control

Because there are few management options available, preventive tactics are the best way to minimize hemp russet mite problems in greenhouse production. If you suspect or see signs and symptoms of hemp russet mite, remove the suspected plants immediately and isolate until a precise diagnosis can be done. Be mindful while transporting or moving plants from one place to another, they can easily spread mites and other pests

throughout the plant population.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Mite (Two-spotted spider)

Two-spotted spider mite (*Tetranychus urticae*)

Pest description and crop damage Two-spotted spider mite (TSSM) (Order: Acari; Family: Tetranychidae) is a polyphagous piercing-sucking mite pest with over 300 host plants. TSSM is small in size (about 1/50 inch), oval in shape and normally pale yellow to bright green in color with two large characteristic dark spots on the either side of the body. TSSM adults have four pairs of legs, and male adults are smaller than the female adults. TSSM can be observed with the naked eye, but microscopy can further assist in proper identification.

TSSM is mainly a concerning pest in indoor hemp production as it is usually managed by naturally occurring biological control agents (natural enemies) in outdoor production. TSSM feeds on plant cell contents and can be found on the underside of hemp leaves. TSSM feeding causes white stippling marks (look like pin pricks) on the hemp plant leaves. Additionally, black spots on the leaves consisting of mite feces are often visible. In some situations, TSSM causes webbing that can cover hemp flower buds or, in extreme cases, whole plants.

Biology and life history TSSM can infest hemp plants in both indoor and outdoor production in the PNW. Populations can build quickly when there is high temperature and low humidity, and in such ideal conditions TSSM can potentially complete a lifecycle in just over a week. In indoor hemp production systems, TSSM may complete a lifecycle in 1-2 weeks. TSSM females usually deposit spherical eggs on the leaf surface, typically on the underside of leaves, and the size of an egg is about one-third the size of an adult female. In about 2 days, a minute 6-legged larva emerges from the egg and starts to feed. The larva then molts to an 8-legged nymph and goes through one more nymphal stage before turning into an adult. Immediately after emergence, adults mate and start to produce eggs. In outdoor conditions, TSSM populations overwinter as adult females in leaf litter and other debris on the soil surface, and they are orange red in color compared to pale yellow to bright green color during summer.

Scouting and thresholds As discussed above, TSSM populations are usually controlled by natural enemies in outdoor hemp production, and scouting is usually not critical. Recent research from Colorado State University and Virginia Tech University suggest that even if TSSM infests hemp plants grown outdoors, the injury is unlikely to be significant. On the other hand, mite scouting is important in indoor hemp production. It is important to inspect the plants and quarantine as needed prior to introducing plants to the greenhouse.

Management—biological control

TSSM populations can be effectively controlled by biological control agents. Specifically, the predatory mite *Phytoseiulus persimilis* is reported to be an effective biological control agent against TSSM, and this agent is commercially available in the US. Other biological control agents for TSSM include green lacewing larvae and minute pirate bugs.

Management—cultural control

Removing TSSM infested hemp plants and isolating them from clean plants can help to minimize the spread of TSSM in indoor production.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Stink bug

Pentatomidae—several species

Pest description and crop damage Stink bug (Order: Hemiptera; Family: Pentatomidae) damage is usually a flagging of leaflet, leaf, or stem and can cause small plants to wilt. Stink bugs are present on hemp in isolated pockets in the PNW.

Biology and life history Stink bugs colonize hemp from other crops and from native plant communities. Eggs are laid in masses of a few dozen at a time. Nymphs (5 instars) can develop quickly and form large populations under the right conditions. It is not known if they can complete a life cycle solely on hemp.

Scouting and thresholds Detecting an infestation is rare. Stink bug adults and nymphs are both easily detected during normal scouting operations using a beating sheet/tray.

Management—biological control

Like many pests of hemp, stink bugs are preyed upon primarily by the various generalist predators present in most hemp fields.

Hemp—Whitefly

Greenhouse whitefly (*Trialeurodes vaporariorum*)

Pest description and crop damage Adults (Order: Hemiptera; Family: Aleyrodidae) resemble tiny white moths about 0.1 inch long. Immature forms look like scale insects and are completely sedentary after the first nymphal instar. Whiteflies rarely, if ever, require control in PNW hemp

fields. However, in hemp plants grown in greenhouses for transplant, white flies can become a nuisance pest.

Biology and life history Greenhouse whitefly is a common pest of many crops and ornamental plants all over the world. Eggs are laid individually on leaves, the immature stages remaining on the same leaf throughout development. Therefore, larger whitefly nymphs will be found on mid-canopy leaves. The final immature stage is much like a pupa, with the adult developing inside the cast nymphal skin. Whiteflies have short generation times, with multiple generations per season.

Scouting and thresholds As noted above, whiteflies rarely reach populations requiring control outdoors, reducing the importance of including them in scouting programs. Adult whiteflies are easy to spot flying within the plant canopy. Whitefly nymphs are much more difficult to measure—a leaf sampling scheme is required since they are not dislodged during beating sheet/tray sampling. There is no established treatment threshold for whiteflies in PNW hemp fields and they are generally not a pest outside of the greenhouse.

Management—biological control

Whiteflies are prey for many generalist predators as well as specific parasitoids. This may partially explain the infrequency with which they become abundant in PNW hemp. In greenhouses, *Encarsia formosa*, which is commercially available, is an excellent biological control agent. It has not been tested in whiteflies affecting hemp.

Management—chemical control

See:
Pesticide Table for Hemp Pests

Hemp—Wireworm

Includes:
Limonius spp.
Agriotes spp., and other wireworm species

Pest description and crop damage Wireworms (Order: Coleoptera; Family: Elateridae) are the most important soil-dwelling pests infesting crops in the PNW. The adults, known as click beetles, do little or no damage; they feed on flowers. The larval or immature stages cause major damage to seedlings and the underground portions of many annual crops, including hemp. The larvae are shiny white at first, but later become straw color or light brown. They look wiry and are about 1 inch long when mature depending on species.

See:
Potato, Irish—Wireworm

Biology and life history Depending on species, wireworms may require two to six years to mature. They overwinter 12 to 24 inches deep in the soil and return near the surface in spring to resume feeding. Mature larvae pupate in the soil, developing into adults that will remain in the soil until the following spring, when they emerge, mate, and lay eggs. Because the female beetles fly very little, infestations do not spread rapidly from field to field. Soil temperature is important to wireworm development and control. Larvae start to move upward in the spring, when soil temperature at the 6-inch depth reaches 50°F. Later in the season, when temperatures reach 80°F and above, the larvae tend to move deeper than 6 inches, where most remain until the following spring. In hemp, they can cause wilting in small plants, especially on fields that follow pastures.

Scouting and thresholds Ideally, the presence of wireworm in a field should be determined before using control measures. However, effectively determining wireworm density is difficult and/or impractical on the large fields that are the rule in many areas. Crop sequence also is important; thus, planting a susceptible crop such as hemp immediately following pasture, grass hay, red clover, or grain is risky. In fields that are plowed deeply in the fall, wireworms will turn up during plowing. They may be detected by following behind the plow and checking for them in the turned-up soil. Fall plowing, however, is becoming much less common. There are no established treatment thresholds for wireworms in hemp.

Management—cultural and biological controls

Crop rotation is an important tool for wireworm control. Wireworms tend to increase rapidly among red and sweet clover and small grains (particularly barley and wheat). Birds feeding in recently plowed fields destroy many wireworms. However, in seriously infested fields this does not reduce the overall pest population. There are no parasites or biological insecticides known to be effective in wireworm control.

For more information, see https://cdn.intechopen.com/pdfs/28267.pdf

Management—chemical control

See:
Pesticide Table for Hemp Pests

Pesticide Table for Hemp Pests

Much of the information below comes from the Oregon Department of Agriculture "Guide List for Pesticides and Cannabis" https://www.oregon.gov/oda/shared/Documents/Publications/PesticidesPARC/GuidelistPesticideCannabis.pdf (updated 11/01/23)

For biological control agents and other biological treatments refer to "Biological Control of Nursery Pests" in the PNW Handbook: https://pnwhandbooks.org/insect/hort/nursery/biological-control-nursery

Active Ingredient	Trade Name	Target Pest(s)	Insecticide Group	Signal Word	Restricted Use?	REI	PHI (days)
azadirachtin	Many brands, and formulations	aphid, leafhopper, whitefly, thrips, lygus bug and spider mite	--	Caution	N	4 hr	0
azadirachtin and pyrethrins	Azera (Valent)	aphid, leafhopper, whitefly, thrips, lygus bug and spider mite	3A	Warning	N	12 hr	0
Bacillus thuringiensis var. *aizawai*	Agree (Certis Biologicals), XenTari (Valent)	corn earworm, tobacco budworm and lepidopteran moth caterpillar	11A	Caution	N	4 hr	0
Bacillus thuringiensis var. *kurstaki*	Dipel (Valent) Javelin (Certis Biologicals)	corn earworm, tobacco budworm and lepidopteran moth caterpillar	11A	Caution	N	4 hr	0
Beauveria bassiana, strain ANT	BioCeres (BioSafe)	aphid, whitefly, thrips, lygus bug	--	Caution	N	4 hr	0
Beauveria bassiana, strain ANT, pyrethrins	BotaniGard Maxx (LAM International)	aphid, leafhopper, whitefly, thrips, lygus bug, spider mite	--	Warning	N	12 hr	0
Beauveria bassiana, strain GHA	Mycotrol (Bioworks), Botanigard ES, BoteGHA (LAM International) Botanigard, Mycotrol (Bioworks)	aphid, leafhopper, whitefly, thrips, lygus bug, spider mite	--	Caution	N	4 hr	0
Heat-killed *Burkholderia* spp. strain A396 cells and spent fermentation media	Venerate CG and Venerate XC (Marrone Bio Innovations)	aphid, caterpillar, corn earworm, leafhopper, mealybug, mites, thrips, whitefly	-	Caution	N	4 hr	0
Chromobacterium subtsugae strain PRAA4-1T	Grandevo CG and Grandevo WDG (Marrone Bio	aphid, caterpillar, corn earworm, leafhopper,	--	Caution	N	4 hr	0

	Innovations)	mealybug, mites, thrips, whitefly					
kaolin	Surround WP (Novasource)	grasshopper, leafhopper, lygus bug,	--	Caution	N	4 hr	0
neem oil	Trilogy (Certis), Debug ON (Agro Logistic Systems)	aphid, whitefly, thrips, spider mite	--	Caution	N	4 hr	0
petroleum-derived oil	Many brands	leafhopper, mites, whitefly,	--	Caution	N	4 hr	0
potassium salts of fatty acids	M-Pede (Gowan), DES-X (Certis)	leafhopper, lygus bug, thrips, mites, whitefly	--	Warning	N	12 hr	0
essential oil extracts	Many brands and formulations	caterpillar, beetles, aphid, leafhopper, thrips, whitefly, spider mite	--	Warning	N	0 hr	0
vegetable-derived oil	Many brands and formulations	aphid, leafhopper, thrips, whitefly, spider mite	--	Caution	N	4 hr	0
polyhedral occlusion bodies (OBs) of the nuclear polyhedrosis virus of *Helicoverpa Zea*	Gemstar LC (Certis Biologicals)	corn earworm, tobacco budworm,	--	Caution		4 hr	0