This is a preview of the 674-page 2008 edition of the PNW Insect Management Handbook. For ordering information, please see next page.

2008
PACIFIC NORTHWEST

Insect
MANAGEMENT HANDBOOK

This book is revised annually.

Poison emergency telephone number is on inside front and inside back covers.

Extension Services of Oregon State University,
Washington State University, and University of Idaho.

Honey bee (Apis mellifer) *on blackberry. Photo: Lynn Ketchum, Oregon State University.*

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Insect
MANAGEMENT HANDBOOK

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We also recognize the considerable assistance from experts within the PNW agricultural community who provided information that contributed to the quality of this handbook. These experts include county extension agents and specialists, product representatives, food processing representatives, agricultural experiment station staff and private consultants.

Contents

Introduction

Craig S. Hollingsworth

To make a prairie it takes a clover and one bee,
One clover, and a bee,
And revery.
The revery alone will do,
If bees are few.
—Emily Dickinson

Emily Dickinson's prairie would be a very barren place without bees. Bees provide the energy necessary for the reproduction and survival of many plant species. There are about 3500 species of bees in North America, all of them collecting pollen and nectar to feed their young, thus becoming dependent on flowers, and through co-evolution, the flowers becoming dependent on bees. Most bees are solitary, but a few species—notably the honey bee—are social, dividing the work of the colony and cooperating in the care of the young.

The honey bee is not native to the United States, but was introduced during early European colonization. Because it has a wide host range and its colonies are easily manipulated, it has become a critical factor in the pollination of agricultural crops. In the U.S., honey bees pollinate over fifty agricultural crops. World-wide, they pollinate one-third of the human diet. Recently the media has drawn attention to the importance of bees with reports of Colony Collapse Disorder (CCD), in which seemingly healthy bees are abandoning their hives. A number of causes have been proposed for CCD but no single factor has been shown to be the cause (though a recent publication in *Science* showed that Israeli Acute Paralysis virus to be present in CCD colonies but absent in healthy colonies). Most entomologists look at CCD to be the result of a combination of factors affecting bee health—and pesticides are at the top of the list of mortality factors.

This issue of the PNW Insect Management Handbook celebrates the bee. We celebrate with a cover photo taken by Lynn Ketchum of Corvallis; with poetry; and with the recognition of our responsibility to protect bees, including honey bees, leafcutting bees, alkali bees, bumble bees, and the thousands of other bee species that pollinate our crops and flowering plants throughout the ecosystem. This year, in addition to the article, *How to Reduce Bee Poisoning from Pesticides*, we include a new section on controlling the pests of honey bees.

We offer our thanks to the over 50 contributors who reviewed the current management practices for crops in the Pacific Northwest. As in past years, Dr. Len Coop will post the *PNW Insect Management Handbook* on the internet at http://pnwpest.org/pnw/insects. The web version of the manual includes links to pest photographs, fact sheets and pesticide labels. Interest in the web version continues to be high: the 2007 web version of the manual received 80,033 hits.

How to report errors / comment on the handbook

The editors of this handbook are very interested to know how well it meets your needs, as well as how it might be improved. Also, while we take pains to deliver the most accurate information available and we proofread the text extensively, errors do occur. We welcome all relevant comments and suggestions. Please send these to chollingsworth@umext.umass.edu. It would be helpful if you include "PNW Insect Handbook" in the first part of the subject line.

Pesticide recommendations

Throughout the *PNW Insect Management Handbook*, you will see the following statement: "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."

By law, applicators of pesticides must have in their possession current product labels and must use pesticides in a manner consistent with label directions. If, for any reason, directions given in this publication are not consistent with the label, you are still legally bound by label restrictions. Pesticide labels always take precedence over entries contained in this Handbook, except as noted below.

The following are exceptions to this under current EPA definitions. It is legal to apply pesticides in any of the following ways:

1. More dilute than on the label
2. At a lower rate than on the label
3. Less frequently than on the label
4. For pests not on the label, as long as the site or crop is listed and other restrictions are observed

It is **illegal** to apply pesticides in the following ways:

1. Using less diluent (water) than on the label (increasing concentration)
2. At a higher rate per acre than on the label
3. Shortening the specified interval between applications
4. Shortening the preharvest interval (minimum number of days between the last application and crop harvest)

In this *PNW Insect Management Handbook*, there are a few insecticide uses that are listed for the control of certain pests not specifically found on a label, but for which the site is listed. These are legal uses and represent the best recommendation(s) based on available data. Note that a University of Idaho Pesticide Committee has ruled that university personnel shall recommend no pesticide registered in Idaho for control of pests not on the label.

Pesticides are registered federally under Section 3 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended in 1972, 1975, 1978, and 1988. This law also permits registration (Section 24c) within states under certain conditions to satisfy special local needs.

Because 24c uses are state-initiated, they usually are not on container labels. They are on supplemental labels (literature) that must be in the possession of pesticide applicators. These uses are identified in the Handbook as 24c with the state or states holding the registration identified; for example, OR, WA, 24c.

A third type of registration (Section 18) permits, at the discretion of the administrator of the EPA, special emergency exemption from the provisions of FlFRA-amended. These emergency uses are so ephemeral, limited, and unpredictable that they are not included in this handbook. Print-on-demand labels and Special Local Need (SLN 24c) documents for many currently registered pesticides are available from the following website: http://www.cdms.net/manuf/manuf.asp

While pesticide products listed in this handbook are registered, this in no way guarantees efficacy in all circumstances and in every geographical area covered. Pesticide resistance in local areas may render some products ineffective.

There may be insecticide names, formulations, and rates labeled for pests or sites that are not included in the Handbook. Conversely, not all labels for a given product may include every pest mentioned. **It is the responsibility of the user to comply with label directions on the product applied.**

Developing a format for the use of trade and/or common names in this handbook that would be most useful to the reader has resulted in compromise. The common name is used alone when it is well known. Otherwise, trade names and common names occur together for clarity. The Acute Toxicity Data section of the handbook lists common names, trade names, and chemical definitions of insecticides. Due to the rapidly changing nature of labels and trade names, omissions may occur.

The information herein is supplied with the understanding that no discrimination is intended and that listing of commercial products, necessary to this handbook, implies no endorsement by the authors or the Extension Services of Oregon, Washington, or Idaho. Criticism of products or equipment not listed is neither implied nor intended.

Due to constantly changing labels, laws, and regulations, the Extension Services can assume no liability for the suggested use of chemicals contained herein. **Pesticides must be applied according to the label directions on the pesticide container**.

"Our Neighbors' Children" by Emilie Benson-Knipe

Be Kind to Your Neighbor

Don't "share" insecticides with your neighbors. Drift from insecticides that you are using won't help your neighbor, and may cause trouble. Chemicals on hay crops or pastures may result in residue in meat or milk.

Small amounts of some insecticides, such as carbaryl, methoxychlor, and malathion, will not create a residue problem on forage crops. But watch out for drift of insecticides.

Select insecticides wisely. Read the pesticide safety section. This information will aid you in choosing an insecticide that will keep you on good terms with your neighbor.

The good neighbor also makes sure that empty insecticide containers are disposed of safely. You can find procedures for safe disposal of highly toxic insecticide containers in the *Pesticide Regulation* section of this handbook.

Agronomic Crops

Brassica (Canola, Rape) Seed Pests

Dave Bragg and Craig S. Hollingsworth

Latest revision—11/07

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 pollinating insects: see "How to Reduce Bee Poisoning from Pesticides," in this handbook.

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

Canola, Rape seed—Aphid

Cabbage aphid *(Brevicoryne brassicae)*
Turnip aphid *(Hyadaphis pseudobrassicae)*

Pest description and crop damage Both species are gray mealy plant lice that form colonies on foliage and racemes, causing flow blast and pod deformity and reducing yield potential. The cabbage aphid appears much earlier than the turnip aphid.

Management—chemical control

1. bifenthrin (Capture 2E) at 0.04 lb ai/a. PHI 35 days. May be applied at bloom. Do not exceed 0.08 lb ai/a per season. Do not apply less than 14 days apart.
2. imidacloprid (Gaucho 600F) seed treatment at 0.4 to 1 lb ai/cwt at seeding. PHI 45 days when applied as seed treatment.
3. lambda-cyhalothrin (Warrior) at 0.03 lb ai/a. Do not apply more than 0.09 lb ai/a per season.
4. methyl- parathion (Cheminova Methyl Parathion 4EC) at 0.5 lb ai/a. PHI 28 days. Do not apply more than twice per season. Apply only in evening. SLN ID-940005. ID only.
5. pymetrozine (Fulfill) at 0.086 lb ai/a. PHI 14 days. Do not exceed 0.17 lb ai/a per season. Allow at least 7 days between applications. REI 12 hrs. SLN WA-000017 expires 12/31/09; OR-040004 expires 12/31/07. WA and OR only.
6. thiomethoxam (Cruiser 5FS) seed treatment at 0.8 to 1.5 oz ai/cwt. PHI 45 days when applied as seed treatment. Efficacy similar to the higher label rate for imidacloprid.

Canola, Rape seed—Cabbage seedpod weevil

Ceutorhynchus asimilis

Pest description and crop damage A seed weevil, small and gray with a snout. They congregate as adults on flowers. They eat three seeds per larvae in the pod, reducing yield to as low as 30% of potential yield. They also vector Alternaria leaf spot on the pods, which is common in Canada and moving into the Palouse region of the PNW.

Management—chemical control

1. lambda-cyhalothrin (Warrior) at 0.015 to 0.03 lb ai/a. Do not apply more than 0.09 lb ai/a per season.
2. imidacloprid (Gaucho 600F) seed treatment at 0.6 to 1.0 lb ai/cwt at seeding. PHI 45 days when applied as seed treatment.
3. methyl-parathion (Cheminova Methyl Parathion) at 0.5 lb ai/a. PHI 28 days. Do not exceed two applications per season. Apply only in evening. SLN ID-940005.
4. zeta-cypermethrin (Mustang Max) at 0.04 lb ai/a. PHI 35 days. REI 12 hrs.

Canola, Rape seed—Cabbage flea beetle

Phyllotreta cruciferae

Pest description and crop damage Adults are blue-black jumping beetles. They attack seedlings, damaging apical meristem, reducing stand, and deforming plants. Larvae feed on roots. Adult beetles are the damaging stage. They also can attack developing pods, resulting in shatter loss of seed.

Management—chemical control

1. bifenthrin (Capture 2E) at 0.04 lb ai/a. PHI 35 days. May be applied at bloom. Do not exceed 0.08 lb ai/a per season. Do not apply less than 14 days apart.
2. chlothianidin (Poncho 600) seed treatment at 0.15 lb ai/cwt at seeding.
3. imidacloprid (Gaucho 600F) seed treatment at 0.4 to 1 lb ai/cwt at seeding. PHI 45 days when applied as seed treatment.
4. lambda-cyhalothrin (Warrior) at 0.015 to 0.03 lb ai/a. Do not apply more than 0.09 lb ai/a per season.
5. methyl-parathion (Cheminova Methyl Parathion) at 0.5 lb ai/a. PHI 28 days. Do not exceed two applications per season. Apply only in evening. SLN ID-940005.
6. thiamethoxam (Cruiser 5 FS) at 0.8 to 1.5 oz ai/cwt. Seed treatment similar to imidacloprid. Consult your extension office for more information.

Canola, Rape seed—Cabbage maggot

Delia brassicae

Pest description and crop damage Maggot larvae feed on roots but seldom cause damage.

Management—chemical control

Consult the Extension agent in your area for specific recommendations.

Canola, Rape seed—Lygus bug

Lygus spp.

Pest description and crop damage Adult bugs (not nymphs) feed on developing buds, flowers, and seedpods resulting in distortion and abortion.

Management—chemical control

1. bifenthrin (Capture 2E) at 0.04 lb ai/a. PHI 35 days. Retreatment interval 14 days. May be applied at bloom. Do not exceed 0.08 lb ai/a per season.
2. cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. PHI 1 day. Do not exceed 0.09 lb ai/a per season. See label for resistance management recommendations.

Field and Silage Corn Pests

John Rinehold, Craig S. Hollingsworth and Glenn Fisher

Latest revision—10/07

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

Field and silage corn—Aphid

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

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

Management—chemical control

1. azadirachtin (Aza-Direct) at 16 to 32 oz formulated product/a. PHI zero days. REI 4 hr.
2. bifenthrin (Capture 2EC) at 0.03 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. Do not apply within 25 ft of an aquatic habitat, or within 150 ft when applied from the air. ULV forbidden
3. chlorpyrifos (Lorsban 4E) at 0.5 to 1 lb ai/a. PHI 35 days for grain harvest or corn fodder, and 14 days for grazing or silage harvest. REI 24 hr. Apply as a postemergence broadcast spray or through overhead sprinklers. Re-treat as necessary, but do not exceed 3 lb ai/a per season.
4. deltamethrin (Decis 1.5 EC, Delta Gold) at 0.018 to 0.022 lb ai/a. Suppression only. PHI 21 days for grain or fodder, 12 days for forage or grazing. REI 12 hr. Do not apply more than 0.095 lb ai/a per season.
5. dimethoate at 0.33 to 0.5 lb ai/a. PHI 14 days of harvest or grazing. REI 48 hr. Make no more than three applications per year. Do not apply during pollen shed if bees are foraging actively.
6. esfenvalerate (Asana XL) at 0.03 to 0.05 lb ai/a. PHI 21 days. REI 12 hr. Do not exceed 0.25 lb ai/a per season.
7. gamma cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. Suppression only. PHI 1 day for grazing and forage, or 21 days for fodder and silage. REI 24 hr.
8. lambda-cyhalothrin (Warrior) at 0.02 to 0.03 lb ai/a. PHI 1 day for in-field grazing or corn forage harvest as feed; 21 days of harvest or cutting fodder and silage. 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. Do not apply within 25 ft of an aquatic habitat, or within 150 ft when applied from the air.
9. malathion at 1 lb ai/a. PHI 5 days. REI 12 hr.
10. methomyl (Lannate) at 0.22 to 0.45 lb ai/a. PHI 21 days for ears, 3 days for forage, or 21 days for fodder. REI 48 hr. Do not exceed 2.25 lb ai/a or 10 treatments per season. Do not apply within 25 ft of an aquatic habitat, within 100 ft when applied from the air, or within 450 ft when using a ULV.
11. methyl parathion at 0.25 lb ai/a. PHI 12 days. REI is 5 days where annual rainfall is less than 25 inches, or 4 days where it exceeds 25 inches. Do not apply during pollen shed.
12. phorate (Agrisolutions) 20G at 1 lb ai/a. Apply over the crop to whorl stage before tasseling with ground equipment to control aphids and mites. PHI 30 days to cutting or forage. REI 48 hr. Use only once per season.
13. zeta-cypermethrin (Mustang) at 0.034 to 0.05 lb ai/a. PHI 30 days for grain and stover, and 60 days for forage. REI 12 hr. Do not exceed 0.2 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, within 150 ft when applied from the air, or within 450 ft when using a ULV.

Field and silage corn—Armyworm

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

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

Management—chemical control

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

1. *Bacillus thuringiensis* bacterial insecticide—PHI zero days. Use according to individual manufacturer's label instructions.
2. beta cyfluthrin (Baythroid XL) at 0.0125 to 0.022 lb ai/a. PHI zero days for green forage and 21 days for grain or fodder. REI 12 hr. Do not exceed four applications or 0.088 lb ai/a per season. Do not apply within 25 ft of an aquatic habitat, within 150 ft when applied from the air, or within 450 ft when using a ULV.
3. bifenthrin (Capture 2EC) at 0.03 to 0.1 lb ai/a, 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 within 25 ft of an aquatic habitat, or within 150 ft when applied from the air. ULV forbidden.
4. carbaryl at 1 to 2 lb ai/a. PHI 14 days for forage or silage grazing, and 48 days for grain harvest. REI 12 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.
5. carbofuran (Furadan 4F or LFR) at 1.2 oz ai/1,000 row ft. PHI 30 days for cutting forage or harvest. Do not exceed two applications or 1 lb ai/a per year. Gives 4 to 6 weeks control when used at planting.
6. chlorpyrifos—
   a. Lorsban 15G at 0.056 to 0.075 lb ai/1,000 row ft (postplant). PHI 35 days for grain harvest or corn fodder, and 14 days for grazing or as silage. REI 24 hr. Do not exceed 0.15 lb ai/1,000 row ft or 3 lb ai/a per season. Apply as a band or as in-furrow treatment at planting.

Bee Protection

Honey Bee Pests

W. Steven Sheppard and Craig Hollingsworth

Latest revision—1/08

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.

Pesticides are a significant cause of bee loss. Refer to *How to Reduce Bee Poisoning from Pesticides*, in this handbook or PWN591 at: http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf.

Honey Bee—Small hive beetle

Aethina tumida

The small hive beetle was first reported to occur in the United States in 1998. The SHB is believed to be native to sub-Saharan Africa and is now known to occur in over 30 states in the U.S. As a hive pest, SHB larvae feed on honey and pollen stores and may also affect brood combs. The major SHB problem reported from states where the beetle occurs has been damage to stored honey. Storage of honey under conditions of reduced relative humidity (< 50%) has been shown to be effective in preventing SHB egg hatch and reducing larval damage. This pest has not yet been reported in the Pacific Northwest.

Honey Bee—Tracheal mite

Acarapis woodi

Pest description Trachael mites are microscopic parasites that live in the tracheal tubes of adult honey bees. To identify them, bees must be dissected under a microscope. Infected colonies of bees have dwindling populations, do not cluster well and often die during the winter.

Management—chemical control

1. menthol. Treat in fall or early spring. Treatment must end one month before the first nectar flow.
2. vegetable oil (1 part) plus 2 parts white granulated sugar, formed into a 0.5 lb patty. Place on broodnest top bar during spring and autumn.

See Ohio State University HYG-2164-97, *Controlling Tracheal Mites in the Bee Hive*. *http://ohioline.osu.edu/hyg-fact/2000/2164.html*

Honey Bee—Varroa mite

Varroa destructor

Pest description and damage. These mites are external parasite of honey bees, feeding on the haemolymph (blood) of adult bees, pupae and larvae. Mites are brown to reddish brown: females are the size of a pinhead, males are smaller. Parasitism results in bee mortality and heavy parasitism can lead to death of the colony.

Management—Monitoring

Varroa mite levels can be determined by placing ½ cup of bees in a jar and adding 2 tablespoons of powdered sugar. Shaking the jar dislodges the mites which can be emptied onto a surface and counted. Vaseline coated trays placed on the bottom board and left for three days will catch mites for monitoring purposes (see reference below).

Management—Cultural Control

Drone trapping- Varroa mites are preferentially attracted to drone brood, thus removal of infested drone combs (drone trapping) can be used to reduce mite populations. Drone comb can be inserted into colonies, removed in the capped brood stage and then frozen to kill the mites. Once re-inserted into the colony, the bees will remove and recycle the nutrient rich dead brood and the combs can be reused. This is most effective in the spring and early summer.

Resistant honey bee stocks – Genetic differences in resistance or tolerance to Varroa mites are known to occur among honey bees subspecies and some commercial strains. A number of behavioral or physiological mechanisms appear to be involved in the resistance, including "Varroa sensitive hygiene," in which mite-infested cells are opened and cleaned out by the hygienic worker bees. Availability and stocks vary, so beekeepers should consult current apicultural periodicals for ongoing developments.

Small cell size – Some evidence suggests that rearing bees in smaller-dimensioned cells reduces Varroa mite reproductive success. Small cell foundation is now commercially available. Given that a colony typically builds about 20% drone comb, regardless of the foundation being used, beekeepers using small cell foundation must still monitor mite populations.

Management—chemical control

1. coumaphos (Check Mite Strips). Remove all surplus honey before treatment.
2. formic acid (Mite Away II). Colony must be reduced to 1-2 supers deep. Remove pads from hive if daily temperature highs exceed 82°F during first 7 days of treatment.
2. fluvalinate (Apistan). Treat before honey flow or during the summer dearth. Destroy any honey left in hive during treatment. Do not re-use strips. If pesticide resistance is suspected, use alternative control measures.
4. menthol, eucalyptus, thymol (Api Life Var). Do not use during honey flows, Do not use when surplus honey supers are installed. Do not harvest honey from brood chambers or colony feed supers. Do not use at temperatures above 90 °F. Two treatments per year are permitted.

See Mid-Atlantic Apicultural Research and Extension Consortium 4.7 *Varroa mites. http://maarec.cas.psu.edu/PDFs/Varroa_Mites_PMP1.pdf*

Legume, Grass, and Field Seed Crops

Alfalfa Seed Pests

Erin W. Hodgson and Glenn Fisher

Latest revision—10/07

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.

Important notice Several pesticides registered for use on alfalfa seed lack legal tolerances established for residues that may be on the seed, screenings, or hay. Therefore, certain alfalfa seed growers associations in Washington, Oregon, Idaho, and Nevada have declared, through their respective state departments of agriculture, that alfalfa produced for seed in those states is a nonfood crop. This declaration means that none of the seed, screenings, or hay will be available for human or animal consumption when special nonfood pesticides have been applied.

EPA and Washington Department of Agriculture have classified most, but not all, small-seeded vegetable seed crops grown in Washington as nonfood/nonfeed crops for pesticide registration purposes.

Alfalfa seed producers should verify the legality of using the products in this section with both a current label indicating that a product is registered for use on alfalfa grown for seed, and the appropriate state department of agriculture.

See also University of Idaho publication CIS 231, *Idaho Insect Control Recommendations for Alfalfa Seed Production,* for additional information.

Protect pollinating insects: see "How to Reduce Bee Poisoning from Pesticides," in this handbook.

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

Alfalfa seed—Alfalfa weevil

Hypera postica

Pest description and crop damage Larvae are about ⅜ inch long, yellow to green, with a white stripe down the back. They feed in and on the buds of alfalfa.

Sampling and thresholds Treat when populations of larvae reach 20 or more per half-circle (180° sweep). That threshold is simply a guideline to help growers determine when to treat. Weather, plant vigor, irrigation schedules, cutting date, history of weevils in the area, and a complex of factors may determine whether treatment is justified.

Management—chemical control

1. bifenthrin

   a. Capture 2EC or Discipline 2EC at 0.06 to 0.1 lb ai/a. REI 12 hr. Do not apply more than three times per season or at intervals less than 21 days. May not be used for hay, forage, or human consumption. Do not apply at ground level within 25 ft of an aquatic habitat, 150 ft if applied by air. SLN ID-900006; ID-040009; OR-900008; OR-040039; WA-890010; WA-040027.

   b. Discipline 2EC at bloom at 0.03 lb ai/a. Same restrictions apply. SLN OR-040039; WA-040027.
2. dimethoate 4EC at 0.25 to 0.5 lb ai/a. PHI 10 days. REI 48 hr. For suppression only. Do not apply if crop or weeds are in bloom. Effective only on cutting to which chemical is applied. Do not feed or graze livestock.
3. gamma-cyhalothrin (Proaxis) at 0.01 to 0.015 lb ai/a. PHI 1 day for forage, 7 days for hay. REI 24 hr. Do not exceed 0.06 lb ai/a per season or 0.015 lb ai/a per cutting. Do not apply on ground within 25 ft of an aquatic habitat, 150 ft if applied by air, or 450 ft if applied from ULV.
4. lambda-cyhalothrin (Warrior) at 0.02 to 0.03 lb ai/a. PHI 1 day for forage, 7 days for hay. REI 24 hr. Do not exceed 0.03 lb ai/a per cutting or 0.12 lb ai/a per season. Do not apply on ground within 25 ft of an aquatic habitat, 150 ft if applied by air, or 450 ft if applied from ULV. Do not apply while bees are active. Advisable to move bee shelters for 2 to 3 days after application.
5. malathion 8EC at 0.75 to 1.25 lb ai/a. PHI zero days. REI 12 hr. Not effective below 65F.
6. methidathion (Supracide 2E) at 0.5 to 1 lb ai/a. PHI 28 days. REI 48 hr. Spray when 20 to 30% of growing tips show feeding damage. Do not apply during bloom. No portion of the field may be used for feed. Idaho and Oregon only. SLN ID-000005; OR-000010.
7. permethrin at 0.1 to 0.2 lb ai/a. PHI zero days at rates equal to or less than 0.1 lb ai/a, 14 days for rates greater than 0.1 lb ai/a or more. REI 12 hr. Do not exceed 0.2 lb ai/a per cutting. If used during bloom, remove bees from field for 3 days.
8. tralomethrin (Scout X-tra) at 0.013 to 0.019 lb ai/a. REI 24 hr. Do not exceed 0.019 lb ai/a per cutting or three applications per season. Do not graze or cut current year's crop for hay or forage. Do not apply by ground within 25 ft or by air within 75 feet of aquatic habitat. Idaho only. SLN ID-930010.
9. zeta-cypermethrin (Mustang) at 0.028 to 0.05 lb ai/acre. PHI 3 days for cutting or grazing, 7 days for harvest. REI 12 hr. Allow at least 7 days between applications. Do not exceed 0.05 lb ai/a per cutting or 0.15 lb ai/a per season. Do not apply on ground within 25 ft of an aquatic habitat, 150 ft if applied by air, or 450 ft if applied from ULV.

Note *Protect* pollinating insects. *See* "How to Reduce Bee Poisoning from Pesticides, " in this handbook.

Alfalfa seed—Alfalfa seed chalcid

Bruchophagus roddi

Pest description and crop damage The adult is a small, shiny black wasp. Larvae feed within a single seed and eventually destroy it.

Small Fruit Crops

Blueberry Pests

Joe DeFrancesco

Lastest revision 11/07

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 carefully before making any pesticide applications.

Protect pollinating insects See "How to Reduce Bee Poisoning from Pesticides," in this handbook.

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

Blueberry—Aphid

Includes blueberry aphid *(Illinoia pepperi)*

Pest description and crop damage Yellowish green to dark green plant lice. They secrete honeydew, deform leaves, and devitalize plants.

Management—chemical control

1. azadirachtin (Neemix and other brands) - Consult label for rate. PHI zero days. Neemix is approved for organic production.
2. diazinon (several brands) at 0.5 to 1 lb ai/a. PHI 7 days. Do not apply during bloom. Not registered for use in ID. Diazinon labels are being revised to allow only one application per season; check label prior to use.
3. imidacloprid (Provado) at 0.0375 to 0.05 lb ai/a. PHI 3 days. Provado is a foliar application; do not apply when bees are actively foraging. Provado and Admire have the same active ingredient (imidacloprid); for resistance management, do not follow one with the other.
4. insecticidal soap (M-Pede and other brands)—Consult label for rate and use directions. PHI zero days. Some brands are approved for organic production.
5. malathion (several brands) at 2 lb ai/a. PHI 1 day. Washington and Oregon only. Apply only in late evening during bloom.
6. methomyl (Lannate) at 0.45 lb ai/a. PHI 3 days. Do not apply during bloom.
7. thiamethoxam (Actara) at 0.047 to 0.062 lb ai/A. PHI 3 days. Foliar applied. Do not apply when bees are foraging; wait at least 5 days after applying Actara before placing beehives in treated field. Actara and Platinum have the same active ingredient; for resistance management, do not follow one with the other.
8. thiamethoxam (Platinum) at 0.078 to 0.188 lb ai/a. PHI 75 days. Apply to soil and incorporate with irrigation. Do not apply when bees are foraging. Platinum and Actara have the same active ingredient; for resistance management, do not follow one with the other.

Blueberry—Blueberry gall midge

Dasineura oxycoccana

Pest description and crop damage The adult is a very small fly, about 1 to 3 mm long, and reddish. The female midge lays eggs in either floral or vegetative buds just after bud swell, when bud scales begin to separate. Eggs hatch into larvae within a few days and begin feeding within the blueberry bud. Larvae are white to orange, very small, within the bud, and difficult to see with the naked eye. There may be several generations per year.

Management—chemical control

Note The following recommendations are legal pesticide uses even though blueberry gall midge may not be listed on the pesticide label; such treatments are not recommended by University of Idaho personnel.

1. diazinon (several brands) at 0.5 to 1 lb ai/a. PHI 7 days. Do not apply during bloom. Not registered for use in ID. Diazinon labels are being revised to allow only one application per season; check label prior to use.
2. malathion (several brands) at 1.25 to 1.75 lb ai/a. PHI 1 day.
3. methomyl (Lannate) at 0.45 lb ai/a. PHI 3 days. Do not apply during bloom.
4. spinetoram (Delegate) at 0.05 to 0.1 lb ai/a. PHI 3 days. Provides suppression only.
5. spinosad (Success or Entrust) at 0.062 to 0.1 lb ai/a. PHI 3 days. Entrust is approved for organic production.

Blueberry—Cherry fruitworm

Grapholitha packardi

Pest description and crop damage Pinkish moth larvae about 0.375 inch long. One larva bores into several berries in a cluster.

Management—chemical control

1. *Bacillus thuringiensis* (*Bt*) (several brands)—Consult label for rate. PHI zero days. A spreader-sticker increases efficacy.
2. carbaryl (Sevin and other brands) at 1.5 lb ai/a. PHI 7 days. Latex-based formulations such as Sevin XLR Plus are less hazardous to bees. Do not apply to bloom.
3. diazinon (several brands) at 1 lb ai/a. PHI 7 days. Do not apply to bloom. Diazinon labels are being revised to allow only one application per season; check label prior to use.
4. esfenvalerate (Asana) at 0.025 to 0.05 lb ai/a. PHI 14 days. Aids in control. Apply prebloom or postbloom only. Esfenvalerate can act like a bee repellent; do not apply within 7 days of pollination.
5. fenpropathrin (Danitol) at 0.2 to 0.3 lb ai/a. PHI 3 days. Do not exceed two applications per season.
6. malathion (several brands) at 1 lb ai/a. PHI 1 day. Apply only during late evening to avoid bee poisoning.
7. methomyl (Lannate) at 0.45 to 0.9 lb ai/a. PHI 3 days. Do not apply to bloom. Apply as spray in 100 gal water/a at blossom drop and again 2 weeks later. Cover foliage thoroughly.
8. spinetoram (Delegate) at 0.05 to 0.1 lb ai/a. PHI 3 days.
9. spinosad (Success or Entrust) at 0.062 to 0.1 lb ai/a. PHI 3 days. Target eggs at hatch or small larvae. Entrust is approved for organic production.
10. tebufenozide (Confirm) at 0.25 lb ai/a. PHI 14 days. Apply

Livestock

Beef Cattle Pests

Peter Schreder, Gene Pirelli, and Gregory Johnson

Latest revision—12/07

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.

Materials suggested for use on dairy animals also may be used on beef animals.

Beef cattle—Cattle grub

Common cattle grub (heel fly) *(Hypoderma lineatum)*
Northern cattle grub *(Hypoderma bovis)*

Management—chemical control

1. doramectin (Dectomax) pour on at 1 ml/10 kg body weight. Do not treat lactating dairy cows or dairy heifers over 20 months of age. Do not treat within 45 days of slaughter.
2. eprinomectin (Eprinex) pour on at 1 ml/10 kg body weight. No slaughter interval, no milk withholding period.
3. famphur (Warbex) at 1 oz per 200 lb of body weight. Do not treat within 35 days of slaughter.
4. fenthion (Tiguvon) spot on at 2.5ml/110 kg body weight (see label chart). Do not treat within 10 days of slaughter.
5. ivermectin (Ivomec) subcutaneous injection at 200 mcg per kg of body weight. Treat as soon as heel fly season is over. Do not treat within 35 days of slaughter.
6. ivermectin (Ivomec, Phoenectin, Prozap) pour on at 1 ml/10 kg body weight. Treat as soon as heel fly season is over. Pour-on treatments are useful in suppressing lice but may not be enough protection against an acute louse problem. Do not treat within 48 days of slaughter.
7. moxidectin (Cydectin) pour on at 1 ml/10 kg body weight, subcutaneous injection at 0.5ml/25 kg body weight. No treatment slaughter interval.
8. trichlorfon (Neguvon) pour on at 32.5 ml/100 kg body weight. Do not treat within 21 days of slaughter.

Beef cattle—Face fly

Musca autumnalis

Management—chemical control

1. cyfluthrin (CyLence) pour on at 4 ml per 400 lb of body weight. Pour along top of back and head. Repeat as needed but no more than once every 3 weeks.
2. cyfluthrin ear tags—One tag to each ear when flies appear. Remove tags at end of fly season or before slaughter.
3. cypermethrin (7%) + chlorpyrifos (5%) ear tag (Max-Con)—Attach two tags per animal. Can be applied to calves under 3 months of age. No withdrawal time required.
4. ddvp (Vapona) spray at 4 lb ai/100 gal water (1% solution). Do not exceed 2 fl oz finished spray solution per animal. Do not wet hide or treat Brahman animals. Do not treat calves less than 6 months old.
5. fenvalerate ear tag—One tag in each ear when flies first appear. Replace in 4 to 5 months if necessary.
6. lambda-cyhalothrin ear tag—One tag to each ear when flies appear. Remove tag after 5 months. Do not use on lactating dairy stock.
7. lambda-cyhalothrin (6.8%) + pirimiphos (14%) ear tag—Use two tags per animal.
8. permethrin RTU applied with mist sprayer. See label directions.
9. permethrin 1% pour on at 0.005 oz ai per 100 lb of body weight to a maximum of 0.05 oz ai per animal. Pour along backline and down face. Repeat as needed but not more than once every 2 weeks.
10. permethrin backrubber or self-oiler at 0.16 oz ai/1 gal mineral oil, diesel oil, or nonirritating organic oil. Keep rubbing device charged. Results improve with forced daily use.
11. permethrin dust, in bag suspended where cattle congregate. Place bags along exit of milking parlor, hanging 4 to 8 inches below animals' backline. Apply 2 oz dust (0.25% dust) per animal. Use in dust bags, shaker can, or mechanical dust applicator.
12. permethrin ear tag—One tag in each ear when flies first appear. Replace in 4 to 5 months if necessary.
13. permethrin spray at 1.5 oz ai/100 gal water. Spray to runoff or use 1 gal per animal. Repeat as needed but not more than once every 2 weeks. For spot treatment, mix 0.75 oz ai/3 gal and spray each animal with 0.5 pint spray mixture per head. See label for other details.
14. tetrachlorvinphos + ddvp (Ravap)—Mix 4 quarts in 75 gal water. Apply as coarse spray. Use 0.5 to 1 gal spray per animal. Beef cattle only.
15. tetrachlorvinphos oral larvicide (Sweetlix) as mineral or feed additive—Use according to individual feed or mineral manufacturer's label directions.
16. zeta-cypermethrin (MagnuM, PYthon)—Attach one to two tags per head. Remove before slaughter.
17. zeta-cypermethrin dust at 2 oz per animal. Apply in dust bag, shaker, dusting glove, or mechanical duster.

Beef cattle—Horn fly

Haematobia irritan

Biology The horn fly was introduced into the United States during the 1800s and spread rapidly across North America. Females lay eggs in fresh cow manure, where the immature form develop. During warm weather the life cycle of a horn fly is 10–20 days, so there are many generations of flies each year. The first appears in June, and the last disappears with hard frosts in fall.

Both sexes have needlelike beaks and suck blood from cattle and other animals. If enough flies are present, this can lead to reduced weight gains or feed efficiency of cattle. However, cattle can tolerate up to 200 horn flies per animal without measurable

Home Garden, Orchard, Landscape, and Lawn Pests

Home Garden—General Pests

Neil Bell and Art Antonelli

Latest revision—11/07

Bee Warning Read carefully before applying any material selected for use. Many insecticides are highly toxic to honey bees. Some should not be applied any time during bloom, while many others should be applied only in the early morning hours and/or late in the evening. Avoid spraying insecticides on plants that are surrounded by blooming flowers or weeds. Always take simple steps like removing (mowing) blooming clover from lawns adjacent to garden areas before applying materials that are hazardous to bees. In all cases, when plants in the infested vicinity are in bloom, select the least hazardous material when given the choice. Avoid using dusts wherever possible; spray formulations are preferred for bee safety. *See* the bee toxicity chart at the back of this publication for specific instructions. Both chemical and nonchemical methods can be accessed via Hortsense on the web at http://pep.wsu.edu/hortsense. It also links to a trade name/active ingredients listing.

Some pests infest a number of vegetable crops, and it would not be practicable to deal with all pests and crops, inclusively. This section discusses some of the most commonly occurring pests, e.g., aphid, earwigs, grasshoppers, slugs, and others, as they relate to home garden vegetables.

Below are materials registered for the control of the pests listed. In all cases, follow the instructions on the pesticide label. Check the label to be certain the formulation you select is registered for the plant and pest that you plan to spray. All materials are not registered for all the plants on which these pests occur, and some may have phytotoxic effects on certain plants. 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.

Home garden—Aphid

Includes
Asparagus aphid *(Brachycorynella asparagi)*
Bean aphid *(Aphis fabae)*
Cabbage aphid *(Brevicoryne brassicae)*
Foxglove aphid *(Aulacorthum solani)*
Green peach aphid *(Myzus persicae)*
Lettuce aphid *(Nasonovia ribisnigri)*
Melon aphid *(Aphis gossypii)*
Pea aphid *(Acyrthosiphon pisum)*
Potato aphid *(Macrosyphum euphorbiae)*
Turnip aphid *(Hyadaphis erysimi)*

Pest description and crop damage Small green, black, pink, or gray, pear-shape insects with long antennae. Aphids also have cornicles, a pair of tubelike appendages that protrude from the back end of the insect and exude honeydew.

Aphids damage plants by sucking plant sap, which causes heavily infested leaves to curl and stunts plants. These aphids also secrete a large amount of honeydew that promotes development of sooty mold on foliage and fruit. They are also responsible for spreading plant disease, particularly viruses. Infestations frequently are localized, with heavily infested leaves curled downward.

Biology and life history Most species of aphids have similar life cycles. Aphid females give birth to live offspring all year without mating. When vegetable crops are not available, aphids live on a wide variety of weed hosts. In summer and fall, aphids may produce winged females and, later, winged males. They mate and produce eggs for overwintering, especially in colder climates. Otherwise, adult aphids overwinter on crops, weeds, or trees. There may be as few as two generations or as many as 16 generations each year, depending on the species and climate.

Scouting and thresholds Check plants frequently after transplant or seedling emergence. Aphids often are concentrated in "hot spots." Be sure to look for evidence of biological control, i.e., the presence of predators, parasites (aphid mummies), and disease. Aphid flights are most common during periods of moderate temperatures (60° to 80°F). Monitor plants particularly closely during April and May.

Management—biological control

Many parasites and predators attack aphids. Monitor the proportion of aphid mummies to unparasitized adults and the number of predators such as lady beetles. If the biocontrol agents appear to be gaining control, avoid sprays which would disrupt this system. Most products available for aphid control are highly disruptive of natural enemy populations.

Management—cultural control

Wash aphids from plants with a strong stream of water. Destroy infested plants immediately after harvest to prevent dispersal. Controlling weeds late in the season may help reduce overwintering populations. Aphid populations tend to be higher in plants that are fertilized liberally with nitrogen. Row covers can be used.

Management—chemical control

Apply to both tops and undersides of leaves.

1. azadirachtin (neem extract)
2. endosulfan
3. insecticidal soap—may require several applications.
4. malathion

Home garden—Armyworm and Cutworm

Includes

Beet armyworm *(Spodoptera exigua)*
Bertha armyworm *(Mamestra configurata)*
Yellowstriped armyworm *(Spodoptera praefica)*
Black cutworm *(Agotis ipsilon)*
Variegated cutworm *(Peridroma saucia)*

Pest description and crop damage Several species of armyworms and cutworms attack vegetable crops. These are green, reddish, or black caterpillars up to 2 inches long. Armyworm caterpillars feed in colonies shortly after hatching and skeletonize leaves. As they grow larger, they tend to disperse and consume irregular patches of leaves or whole leaves. Cutworms feed mostly at the soil line, and may cut off seedling plants at ground level.

Biology and life history Armyworms and cutworms are the larvae (caterpillars) of noctuid moths. Armyworms typically feed during the day, while cutworms spend the day just beneath the soil surface or in plant debris and feed at night. Weeds are the primary food source of cutworms.

Management—cultural control

Control weeds, grasses, and debris in the vegetable garden that provide cover. Hand-pick cutworm larvae, using a flashlight to find them, if practical. Scratch the soil at the base of plants to find larvae in the daytime.

Management—biological control

1. Encourage natural enemies of cutworms like birds and spiders.
2. nematodes—Soil must be warmer than 53°F.

Management—chemical control

Apply any one of these materials to the soil surface at first sign of cutworm activity. Consult label. Minimum preharvest interval (PHI) varies with crop. Difficult to control. Where cutworms are on the soil surface, a carbaryl drench, *when bees are not present,* may help. Beans, tomatoes, and late corn are most often "hoed" by cutworms. Attack varies in severity with locality and year.

1. *Bacillus thuringiensis (Bt)*
2. carbaryl bait
3. spinosad

Insecticide for home garden and orchard pests

Active ingredient	Label type	Chemical Class	Toxicity class	Action	Comments
acetamiprid	insecticide	neonicotinoid	III	contact, systemic	For use on sucking insects
azadirachtin (neem oil)	insecticide	botanical	III/IV	growth regulator	Organic
Bacillus thuringiensis var. kurstaki (*Bt*)	insecticide	microbial	III/IV	larvicide	Organic; controls caterpillars.
Beauveria bassiana	insecticide	microbial	III/IV		Organic
beneficial nematodes	insecticide	biological	III/IV		For use in controlling certain soil-dwelling pests, especially root weevils. Not effective at soil temperatures below 55°F.
capsaicin	repellent	botanical	III/IV		Organic
carbaryl	insecticide	carbamate	I, II, III/IV	broadspectrum	Can cause severe spider mite outbreaks.
cyfluthrin	insecticide	pyrethrioid	III/IV	contact	
endosulfan	insecticide, acaricide	chloronated hydrocarbon	II, III/IV		
esfenvalerate	insecticide	pyrethroid	II, III/IV	broad spectrum, contact	
horticultural oil dormant oil summer oil superior oil supreme oil	insecticide	petroleum distillate	III/IV		Available under a variety of labels. May be in combination with lime or lime-sulfur. Follow directions carefully to avoid plant damage. Dormant oil labels should indicate a U.R. rating of 92% or more.
insecticidal soap potassium salts of fatty acids potassium laurate	insecticide	fatty acid	II, III/IV		Organic. Do not substitute household soaps as plant injury may occur.
iron phosphate	molluscicide	inorganic	III/IV		Low-toxicity slug and snail bait.
kaolin	repellent	inorganic - clay	III/IV		Organic
lambda-cyhalothrin	insecticide, acaricide	pyrethroid	III/IV	broad spectrum	

Integrated Pest Management

Concepts of IPM

Craig Hollingsworth

Latest revision—12/07

Integrated pest management (IPM) is an ecologically-based pest control strategy that relies heavily on natural mortality factors such as natural enemies and weather, and seeks out control tactics that disrupt these factors as little as possible. IPM uses pesticides, but only after systematic monitoring of pest populations and natural control factors indicates a need. Ideally, an integrated pest management program considers all available pest control actions, including no action, and evaluates the potential interaction among various control tactics, cultural practices, weather, other pests, and the crop to be protected.

While dozens of definitions have been proposed for IPM (see: http://ipmnet.org/IPMdefinitions/), the definition above, from Flint and Van den Bosh (1981, *Introduction to Integrated Pest Management*, Plenum Press) has been widely accepted by the agricultural community for nearly 30 years. In particular, it points to IPM's ecological foundation and to the importance of monitoring and selection of multiple control practices.

Depending on the scope and complexity of the management system, an IPM program may target a single pest, a pest category (e.g. insects, weeds, diseases or rodents) or the whole pest complex. While traditional pest control considers each pest exclusively, IPM takes into account the interactions among pests, beneficial organisms, the environment, and the crop.

Development of an IPM system requires a thorough understanding of the biology of the crop (or resource) and of the pest complex. The IPM concept was developed from the realization that most pesticide applications affect both pests and beneficial organisms in the crop, sometimes to the disadvantage of the grower.

An IPM system attempts to maintain pest populations below economically damaging levels by using a balance of biological, cultural, chemical, genetic, or other control methods. IPM systems are flexible and programs may vary with time of year, location, and type of crop. Books, manuals and websites have been devoted to discussions of general IPM principles and to the applications of IPM to specific agricultural and urban systems. However, the following components are generally found in IPM programs:

1. **Management units**. Monitoring is conducted with the aim of providing results for the management of a specific management unit—the part of the system that will receive the same pest control decisions. The unit may be part of a field, a single field or several fields. Chemical control decisions are sometimes based on the area that can be covered by a single spray tank.
2. **Key pests.** An IPM program targets specific pests, which may include insects, mites, plant diseases, weeds or vertebrates. In the development of an IPM program, these pests are identified and monitoring and control programs are designed for each of these pests.
3. **Monitoring**. Sampling should accurately assess the pest pressure and the abundance of beneficial organisms in the management unit. Monitoring is conducted so that management actions can take place in a timely and effective manner.
4. **Pest action thresholds.** Keeping fields entirely pest free is neither necessary nor desirable. Most crops can tolerate low pest infestation levels without any yield loss. IPM seeks to reduce pest numbers below economically damaging levels rather than eliminate infestations. Pesticides should be applied only when economically justified by the numbers of pests present.
5. **Use of multiple controls and tactics**. Control tactics should be employed to make the crop less favorable for pest survival and reproduction, while disturbing the rest of the ecosystem as little as possible. Combining different control tactics into an overall strategy balances the strengths of each against any individual weaknesses. Using different techniques also reduces the probability of the development of pest resistance. Control tactics should be compatible with beneficial organisms and the environment.

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