

- treatment or at 1 to 4 pints/a product as foliar treatment. PHI 7 days.
- b. Vydate C-LV at 68 to 136 fl oz/a product as preplant in-furrow treatment or at 2.1 pints/a product as foliar treatment. PHI 7 days.
21. peppermint oil, rosemary oil (Ecotrol EC) at 1 to 4 pints/a product.
  22. † permethrin (Ambush, Pounce, etc.) at 0.05 to 0.2 lb ai/a as foliar treatment. PHI 14 days. Potato aphid only.
  23. petroleum oil (Biocover) at 0.75 to 1 gallon/100 gallons water. See product label for directions and product compatibility cautions.
  24. phorate (Thimet 20G, Phorate 20G) at 8.5 to 11.3 oz product per 1,000 ft of row in "light or sandy soils" and at 13 to 17.3 oz product per 1,000 ft of row in "heavy or clay soils." PHI 90 days. Federal label for Thimet 20G allows postemergence side-dress application, at the former rate, on "light or sandy soil" only.
  25. pymetrozine (Fulfill) at 1.375 to 2.75 oz ai/a or 2.75 to 5.5 oz product/a as foliar treatment. PHI 14 days. Do not exceed 11 oz product/a per year. Aphids may take 2 to 4 days to die after treatment.
  26. soybean oil (Golden Pest Spray Oil) at 2 gallons per acre. See product label for directions and product compatibility cautions.
  27. ‡ thiamethoxam— See "Special Note about Resistance Management" at the beginning of the potato section.
    - a. Actara at 3 oz/a product as foliar treatment. PHI 14 days. Minimum interval between treatments 7 days. Do not apply more than 0.094 lb ai/a per year.
    - b. Cruiser 5FS at 0.11 to 0.16 fl oz product per 100 lb seed pieces.
    - c. † Endigo ZC—thiamethoxam + lambda cyhalothrin at 4 to 4.5 fl oz/a product as foliar treatment. PHI 14 days.
    - d. Platinum at 5 to 8 fl oz/a product at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, sidedress at emergence, or broadcast to soil at last hilling. Chemigation at emergence is allowed in Idaho and Oregon. Do not apply more than 0.125 lb ai/a per year.
    - e. Platinum 75SG at 1.66 to 2.67 oz/a product at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, sidedress at emergence, or broadcast to soil at last hilling. Do not apply more than 0.125 lb ai/a per year.
    - f. Platinum Ridomil Gold at 2.2 fl oz product per 1,000 row ft at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, or at emergence.
    - g. Voliam Flexi— chlorantraniliprole + thiamethoxam foliar treatment at 4 oz/a product. See "Special Note about Resistance Management" at the beginning of the potato section.
  28. † zeta-cypermethrin—
    - a. Hero—bifenthrin + zeta-cypermethrin foliar treatment at 4 to 10.3 oz/a product.
    - b. Mustang Max at 3.2 to 4 oz/a product as foliar treatment. PHI 1 day. Apply no more than 0.15 lb ai/a per year.

## Potato, Irish—Blister beetle

*Epicauta* spp.

**Pest description and crop damage** Adults feed on the leaves, causing a ragged appearance. Adults are 0.5 inch long, gray to black, narrow and elongate, with conspicuous heads and necks. Larval blister beetles live in the soil in uncultivated land, and are predators of grasshopper and bee eggs. Adults feed on the foliage of many different kinds of plants. These beetles can cause complete defoliation of affected areas, but because they are extremely clumped within a field, little total damage normally results. If control is required, only spot treatments may be needed.

### Management—chemical control: COMMERCIAL USE

Chemical control of blister beetles in potatoes is rarely required.

1. † lambda-cyhalothrin—
  - a. Endigo—lambda-cyhalothrin + thiamethoxam at 3 to 4 fl oz/a product as foliar treatment. PHI 14 days. See "Special Note about Resistance Management" at the beginning of the potato section.
  - b. Warrior II at 1.28 to 1.92 fl oz/a product as foliar treatment. PHI 7 days. Apply no more than 7.68 fl oz/a per year.
2. ‡ thiamethoxam— See "Special Note about Resistance Management" at the beginning of the potato section.
  - a. † Endigo ZC—thiamethoxam + lambda cyhalothrin at 3 to 4 fl oz/a product as foliar treatment. PHI 14 days.

## Potato, Irish—Colorado potato beetle

*Leptinotarsa decemlineata*

**Pest description and crop damage** The Colorado potato beetle (CPB) is a yellow and black striped beetle, about 0.5 inch long and 0.25 inch wide. Larvae are reddish orange, with two rows of black spots on each side. Yellow egg clusters are found on the undersides of leaves. This beetle can cause complete defoliation and nearly complete crop loss if allowed to reproduce unchecked.

**Biology and life history** Both larvae and adults feed on potato foliage throughout the season. Pupation occurs in the soil. Overwintering occurs in the soil, adults emerging to lay eggs in the spring. In cool climates, the beetle undergoes only one generation per season, but in warmer areas, such as the southern Columbia Basin, it may have three generations.

**Scouting and thresholds** Check fields for CPB starting at crop emergence: beetles are easily spotted when plants are small. Because larvae feed toward the tops of the plants, scouting for this insect is easily done as workers walk through fields. There are no established treatment thresholds for CPB. The goal of management should be to limit population growth and spread through fields and farms: large populations are harder to manage than small ones.

### Management—biological control

This insect is unpalatable to some generalist predators, but eggs and young larvae are fed upon by *Geocoris* big-eyed bugs and *Nabis* damsel bugs. There are also two large predatory stink bug species that feed on CPB larvae. In some situations, severe disease-related mortality can occur during pupation and overwintering in the soil.

### Management—cultural control

Crop rotation is very important for CPB management. Adults

overwinter in the soil, so if potatoes follow potatoes, beetles will emerge and immediately infest the new crop.

**Management—chemical control: HOME USE**

1. bifenthrin
2. carbaryl—To avoid harming bees, do not apply products containing carbaryl to plants in bloom.
3. esfenvalerate
4. rotenone (as a mix with pyrethrin)
5. spinosad

**Management—chemical control: COMMERCIAL USE**

The CPB has developed very high levels of resistance to insecticides in many parts of the country. Fortunately, most populations in the Pacific Northwest are still susceptible to most labeled products. The lessons learned by potato growers in the eastern U.S. should still be heeded here:

- a. CPB can develop very high levels of resistance to almost all classes of chemicals.
- b. Carefully rotating chemical modes of action is critical to slow the development of insecticide resistance.

Generally, do not apply controls until egg hatch begins. Border sprays are sometimes an economical choice, especially early in the season before populations build up.

**Caution** Pyrethroid insecticide applications make aphid management more difficult, and can lead to outbreaks of spider mites. Please note the dagger symbol—†—used throughout this section to identify pyrethroids.

1. abamectin (Agri-Mek 0.15EC, many others) at 8 to 16 fl oz/a product as foliar treatment. PHI 14 days. Apply in at least 20 gal/a of water when applying by ground, and at least 5 gal/a of water when applied by air.
2. † acetamiprid (Assail 70 WP, Assail 30 SG) at 0.028 to 0.075 lb ai/a as foliar treatment. Do not exceed four applications per season. PHI 7 days. See "Special Note about Resistance Management" at the beginning of the potato section.
3. aldicarb (Temik 15G NW) at 14 to 20 lb/a product in furrow at planting. PHI 150 days. Positive displacement applicators only. Certification required.
4. azadirachtin (Aza-Direct, Ecozin, etc.) as foliar spray or soil drench. PHI 0 days. Consult specific labels for rates and instructions.
5. *Bacillus thuringiensis* subsp. *tenebrionis* (Novodor). Foliar spray. PHI 0 days. Most effective on small larvae.
6. *Beauveria bassiana* (Botanigard, Mycotrol) as foliar spray. PHI 0 days. Consult specific labels for rates and instructions.
7. † bifenthrin—
  - a. Brigadier—imidacloprid + bifenthrin foliar treatment at 4.8 to 6.14 fl oz/a product.
  - b. Hero—bifenthrin + zeta-cypermethrin foliar treatment at 2.6 to 6.1 oz/a product.
8. carbaryl (Sevin) at 1 to 2 lb ai/a as foliar treatment. PHI 7 days.
9. carbofuran—
  - a. Furadan 4F at 0.5 to 1 lb ai/a as foliar treatment. PHI 14 days. Do not apply by chemigation.
  - b. Furadan 4F at 3 lb ai/a applied from planting to 4-inch rosette. PHI 14 days. Do not apply by chemigation. Idaho, Oregon, Washington 24(c).
10. chlorantraniliprole—
  - a. Altacor at 2 to 3 oz/a product as foliar treatment. Do not apply more than 9 oz per acre per year. Minimum spray interval 5 days.
  - b. Voliam Flexi—chlorantraniliprole + thiamethoxam foliar treatment at 4 oz/a product. See "Special Note about Resistance Management" at the beginning of the potato section.
11. † clothianidin—
  - a. Belay Insecticide at 1.9 to 2.8 fl oz/a product as foliar treatment, or as seed treatment 0.4 to 0.6 fl oz product per 100 lb seed.
  - b. Belay 16 WSG in-furrow or side-dress at 12 to 18 oz/a product. Apply once per season.
  - c. Belay 50 WDG at 1 to 1.5 oz/a product as foliar treatment, or in-furrow or side-dress at 4 to 6 oz/a product. PHI 14 days. Minimum interval between treatments 7 days. No more than 3 applications per year. See "Special Note about Resistance Management" at the beginning of the potato section.
12. cryolite (Kryocide: sodium aluminofluoride) at 10 to 12 lb/a product as foliar treatment. PHI 14 days.
13. † cyfluthrin
  - a. Baythroid 2 at 1.6 to 2.8 fl oz/a product as foliar treatment. PHI 0 days.
  - b. † Leverage 2.7—imidacloprid + cyfluthrin foliar treatment at 3 to 3.75 fl oz/a product. PHI 7 days. Lower rate for ground sprayer application only. For chemigation and aerial application, use 3.75 fl oz/a. See "Special Note about Resistance Management" at the beginning of the potato section.
  - c. Renounce 20 WP at 2 to 3.5 oz/a product as a foliar spray. PHI 0 days.
14. cyromazine (Trigard) at 2.66 or 5.32 oz/a as a foliar spray (Larvae only). Minimum interval between treatments 7 days. PHI 7 days. Do not apply more than 1 lb of product/a per season.
15. † deltamethrin (Battalion 0.2 EC) at 1.5 to 2.4 oz/a product as a foliar treatment. PHI 3 days. Do not exceed 12 oz/a per season.
16. † dinotefuran (Venom) at 1 to 1.5 oz/a product as a foliar treatment or 6.5 to 7.5 oz/a product as a soil treatment at preplant or planting, or as a side-dress. PHI 7 days. Do not exceed 0.754 lb/a per season. See "Special Note about Resistance Management" at the beginning of the potato section.
17. endosulfan—Endosulfan is more effective above 75°F.
  - a. Thiodan 3EC, Endosulfan 3EC at 0.5 to 1 lb ai/a as foliar or chemigation treatment. PHI 1 day. Special chemigation 24(c) label for Idaho.
  - b. Thiodan 50WP, Endosulfan 50WSB at 0.5 to 1 lb ai/a as foliar treatment. PHI 1 day. Do not apply through any type of irrigation system.
18. † esfenvalerate (Asana XL, Adjourn) at 5.8 to 9.6 fl oz/a product as foliar treatment. PHI 7 days. Do not exceed 0.35 lb ai/a per season.
19. † imidacloprid—
  - a. 1.6F formulations (Provado, etc.) at 3.8 fl oz/a product as foliar treatment. PHI 7 days. Do not exceed 15 oz/a product per year. See "Special Note about Resistance Management" at the beginning of the potato section.

- b. 2F and 4F formulations (Admire, etc.) in-furrow at 0.20 to 0.31 lb ai/a. Use only at planting.
  - c. 2F and 4F formulations (Admire, etc.) as seed-piece treatment at 0.0061 to 0.0124 lb ai per 100 lb seed pieces.
  - d. Gaucho-MZ—imidacloprid + mancozeb fungicide seed piece treatment at 0.75 lb product per 100 lb cut seed pieces.
  - e. † Leverage 2.7—imidacloprid + cyfluthrin foliar treatment at 3 to 3.75 fl oz/a product. PHI 7 days. Lower rate for ground sprayer application only. For chemigation and aerial application, use 3.75 fl oz/a. See “Special Note about Resistance Management” at the beginning of the potato section.
  - f. TOPS-MZ-Gaucho—imidacloprid + thiophanate-methyl + mancozeb seed piece treatment at 0.75 to 1 lb product per 100 lb cut seed pieces.
20. † lambda-cyhalothrin—
- a. Endigo—lambda-cyhalothrin + thiamethoxam at 2.5 to 4.5 fl oz/a product as foliar treatment. PHI 14 days. See “Special Note about Resistance Management” at the beginning of the potato section.
  - b. Warrior II at 1.28 to 1.92 fl oz/a product as foliar treatment. PHI 7 days. Apply no more than 7.68 fl oz/a per year.
21. methamidophos (Monitor) at 0.75 to 1 lb ai/a or 1.5 to 2 pints/a product as foliar treatment. PHI 14 days. Do not exceed 4 lb ai/a per season.
22. methyl parathion (Pencap-M) at 2 to 6 pints/a product as foliar treatment. PHI 5 days.
23. novaluron (Rimon) at 9 to 12 fl oz/a product as foliar treatment. PHI 14 days. Do not exceed two applications per year.
24. oxamyl—Do not exceed 4.5 gal product/a per year. Foliar applications may be made by chemigation.
- a. Vydate L at 1 to 2 gal/a product as preplant in-furrow treatment or at 1 to 4 pints/a product as foliar treatment. PHI 7 days.
  - b. Vydate C-LV at 68 to 136 fl oz/a product as preplant in-furrow treatment or at 2.1 pints/a product as foliar treatment. PHI 7 days.
25. † permethrin (Ambush, Pounce, etc.) at 0.05 to 0.2 lb ai/a as foliar treatment. PHI 14 days. Do not exceed 1.6 lb ai/a per season.
26. petroleum oil (Biocover) at 0.75 to 1 gallon/100 gallons water. See product label for directions and product compatibility cautions.
27. phorate (Thimet 20G, Phorate 20G) at 13 to 17.3 oz product per 1000 ft of row in “heavy or clay soils” only, for early season control. PHI 90 days. Federal label for Thimet 20G allows postemergence side-dress application, at 8.5 to 11.3 oz product per 1000 ft of row, on “light or sandy soil” only.
28. phosmet (Imidan 70W) at 1.33 to 2.5 lb/a product as a foliar treatment. PHI 7 days at the low rate, 21 days above the low rate. Do not exceed 6.66 lb/a per season. Rates above 1.33 lb are allowed only under a 24(c) label in Washington.
29. soybean oil (Golden Pest Spray Oil) at 2 gallons per acre. See product label for directions and product compatibility cautions.
30. spinetoram (Radiant) at 6 to 8 oz/a product as foliar treatment. PHI 7 days. May be applied by chemigation.
31. spinosad—
- a. Entrust at 1 to 2 oz/a product as foliar treatment. PHI 7 days. Entrust is approved for organic production.
  - b. Success at 3 to 6 fl oz/a product as foliar treatment. PHI 7 days. May be applied by chemigation.
32. † thiamethoxam— See “Special Note about Resistance Management” at the beginning of the potato section.
- a. Actara at 1.5 to 3 oz/a product as foliar treatment. PHI 14 days. Minimum interval between treatments 7 days. Do not apply more than 0.094 lb ai/a per year.
  - b. Cruiser 5FS at 0.11 to 0.16 fl oz product per 100 lb seed pieces.
  - c. † Endigo ZC—thiamethoxam + lambda cyhalothrin at 2.5 to 4.5 fl oz/a product as foliar treatment. PHI 14 days.
  - d. Platinum at 5 to 8 fl oz/a product at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, sidedress at emergence, or broadcast to soil at last hilling. Chemigation at emergence is allowed in Idaho and Oregon. Do not apply more than 0.125 lb ai/a per year.
  - e. Platinum 75SG at 1.66 to 2.67 oz/a product at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, sidedress at emergence, or broadcast to soil at last hilling. Do not apply more than 0.125 lb ai/a per year.
  - f. Platinum Ridomil Gold at 2.2 fl oz product per 1,000 row ft at planting sprayed in-furrow, impregnated on granular fertilizer and applied before or at planting, or at emergence.
  - g. Voliam Flexi— chlorantraniliprole + thiamethoxam foliar treatment at 4 oz/a product. See “Special Note about Resistance Management” at the beginning of the potato section.
33. † zeta-cypermethrin—Apply no more than 0.15 lb ai/a per year. PHI 1 day.
- a. Mustang at 0.04 to 0.05 lb ai/a as foliar treatment.
  - b. Respect, Mustang Max at 0.02 to 0.025 lb ai/a as foliar treatment.

### Potato, Irish—Cucumber beetle

Western spotted cucumber beetle (*Diabrotica undecimpunctata*)

**Pest description and crop damage** Larvae may feed on tubers in potato fields west of the Cascades. Adults are 0.33 inch long, yellowish green, with distinct black spots on the wing covers. Mature larvae are about 0.33 inch long and white with brown on both ends.

#### Management—chemical control: HOME USE

Apply when beetles first appear and repeat at 7- to 10-day intervals as needed.

1. bifenthrin
2. carbaryl dust—To avoid harming bees, do not apply products containing carbaryl to plants in bloom.
3. malathion
4. permethrin
5. rotenone

#### Management—chemical control: COMMERCIAL USE

1. † bifenthrin—
  - a. Brigadier —imidacloprid + bifenthrin foliar treatment at 4.8 to 6.14 fl oz/a product.