Organic Management of Flea Beetles

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Washington State University • Oregon State University • University of Idaho

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Introduction

Flea beetles are common pests throughout the Pacific Northwest states of Idaho, Oregon, and Washington that attack plants in the families Brassicaceae (e.g., broccoli, kale, cabbage, collards) and Solanaceae (e.g., potatoes, tomatoes, eggplant, peppers). Both larval and adult stages have chewing mouthparts, which they use effectively below ground (larvae) and above ground (adults). Below- and above-ground feeding damage can kill seedlings and small transplants. In addition, scars on tubers from below-ground feeding can reduce marketability, while scars on a variety of foliage from above-ground feeding may render produce unmarketable. Flea beetle feeding damage can sometimes lead to total crop loss.

Flea beetles are highly mobile, which makes control difficult. Growers interested in organic management may feel especially limited. However, organic management of flea beetles includes cultural, physical, biological, and chemical strategies. This publication describes the life cycle and general biology of flea beetles, along with economically and environmentally sound current pest control options.

Flea Beetle Description

The three most common flea beetle species commonly found in the Pacific Northwest are the crucifer flea beetle (*Phyllotreta cruciferae*) on brassicas, the tuber flea beetle (*Epitrix tuberis*) on potato tubers and foliage, and the western potato flea beetle (*E. subcrinata*) on solanaceous crops. Crucifer flea beetle adults are shiny metallic blue-black (Fig. 1a), while both the tuber flea beetle and western potato flea beetle can be dark metallic brown, black, or bronze (Figs. 1b and c). The tuber flea beetle appears dull black in bright light, whereas the western potato flea beetle tends to have a more bronze appearance. The tuber flea beetle and western potato flea beetle are so similar in appearance that only a microscopic inspection of reproductive parts can be used to definitively distinguish between the two species.

Although the adults of all three flea beetles species are small (1/15 to 1/6 inch long), their enlarged hind legs allow them to jump great distances. Additionally, flea beetles are strong fliers, moving into crop fields from neighboring fields and weedy borders. The adults actively search for emerging host plants using visual as well as chemical olfactory (smell) cues.

Life History and Host Plants

Overwintering flea beetle adults emerge in mid- to late spring, become more active when the days get warmer, and move into fields as their preferred host plants become available. Adult flea beetles deposit their eggs in the soil at the base of a host plant where larvae hatch from eggs, feed on below-ground portions of the plant, and then pupate in the soil. Adults emerge to feed on above-ground foliage, then overwinter under protective plant debris (e.g., leaf litter), in grassy field borders, and in ditch banks (Fig. 2). One generation of the crucifer flea beetle and two to three generations of the tuber and western potato flea beetles are completed annually in Washington. Multiple generations of all three flea beetles can be found in Oregon and Idaho. Generally, warmer temperatures allow for more flea beetle generations to be completed.

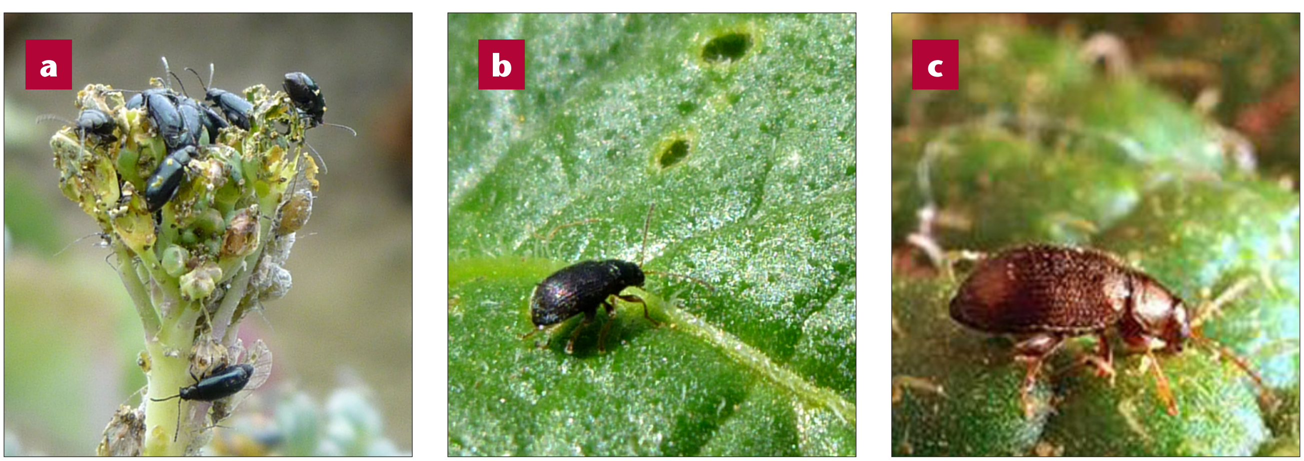

Figure 1. Crucifer flea beetle adults on a broccoli floret (a), tuber flea beetle adult on potato leaf (b), and western potato flea beetle on potato leaf (c). (Photo b provided by G.H. Spitler, Washington State University; photo c by Ken Gray, courtesy of Oregon State University)

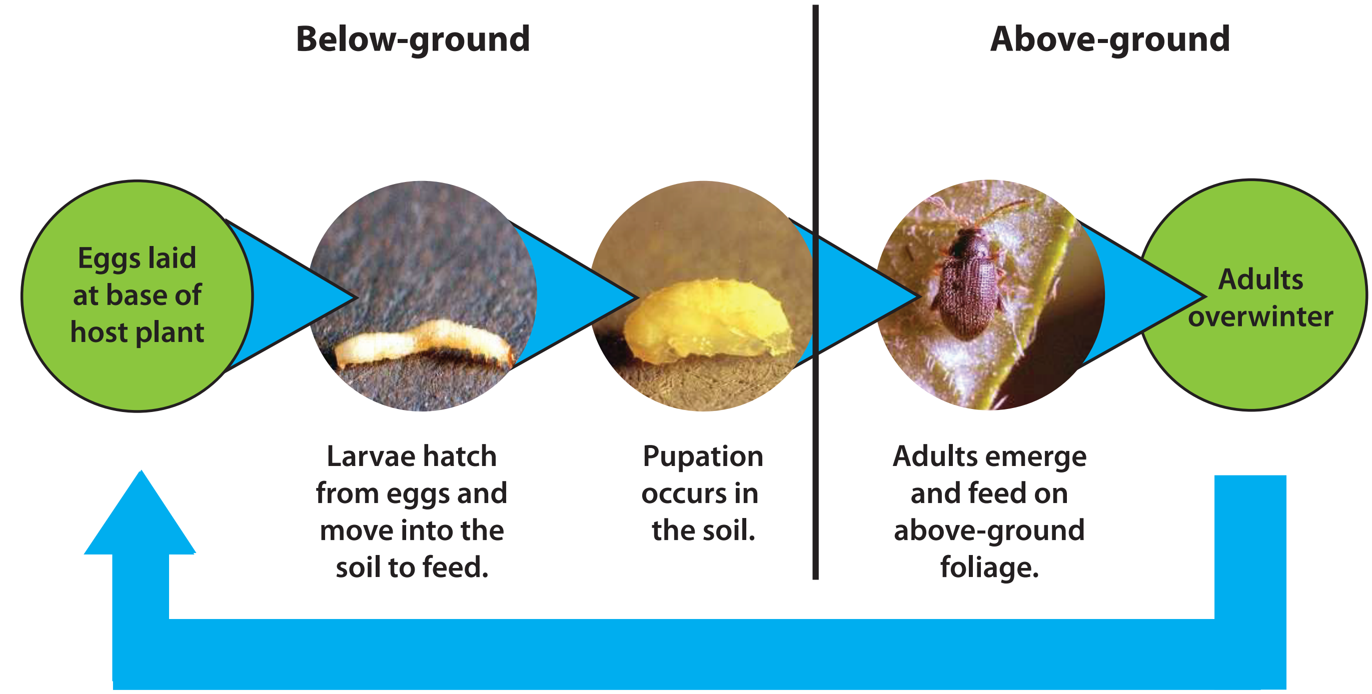

Figure 2. Flea beetle life cycle. (Photos by Ken Gray, courtesy of Oregon State University)

Damage

The crucifer flea beetle generally feeds on plants in the Brassicaceae family (e.g., broccoli, kale, cabbage, collards), while the tuber flea beetle and western potato flea beetle generally feed on plants in the Solanaceae family (e.g., potatoes, tomatoes, eggplant, peppers). On brassica crops, flea beetles feed most heavily on foliage. On solanaceous crops, flea beetle feeding is most important on potato tubers.

Below-ground

Crucifer flea beetle, tuber flea beetle, and western potato flea beetle larvae feed on plant roots and root hairs. Tuber flea beetle larvae also feed on potato tubers. While western potato flea beetle larvae feed primarily on the roots of potatoes, they have also been known to feed on potato tubers.

Tuber flea beetle larval damage to potatoes can be significant. Larvae create winding shallow grooves on the surface of potato tubers that can lead to scar formation (Figs. 3a and b). Larvae can also burrow into the tubers, in which case there will be a small entry hole that is often filled with frass (dark-colored excrement) that can stain the tuber. These holes can also cause indirect damage by serving as entry points for microorganisms that reduce storage potential or cause potatoes to rot. Damage to plant roots and root hairs may cause reductions in the size and health of plants; however, it usually does not result in significant economic loss.

Above-ground

Adult flea beetles feed on above-ground portions of plants, including stems, leaves, and flowers. Chewing damage on leaves results in a characteristic pitting or shotholing. Because broccoli leaves are waxy and thick, feeding damage appears as pitting (Fig. 3c). Damage to the thinner leaves of mustard and potato plants (Figs. 3d and e, respectively) looks like shotholes ranging in size from 1/16 to 1/8 inch in diameter. Severe damage to above-ground plant parts can kill seedlings and young transplants, and in older plants can lead to crop stress, reduced growth, stunting, and eventual death.

Organic Management Methods

Understanding the biology and life cycle of flea beetles will help you determine the most effective suppressive strategies at the optimum time to manage these difficult and destructive pests. For example, crop rotation is usually not a viable management strategy because flea beetles are extremely mobile and can readily migrate from field to field. However, potato tuber flea beetle densities tend to be greater in fields previously planted with potatoes, so you should avoid planting a highly susceptible crop after potatoes. The following are organically approved effective cultural, mechanical, biological, and organic chemical strategies to reduce flea beetle populations.

Cultural

Planting schedule. Flea beetle larvae emerge in mid- to late spring and adults emerge in mid-summer through

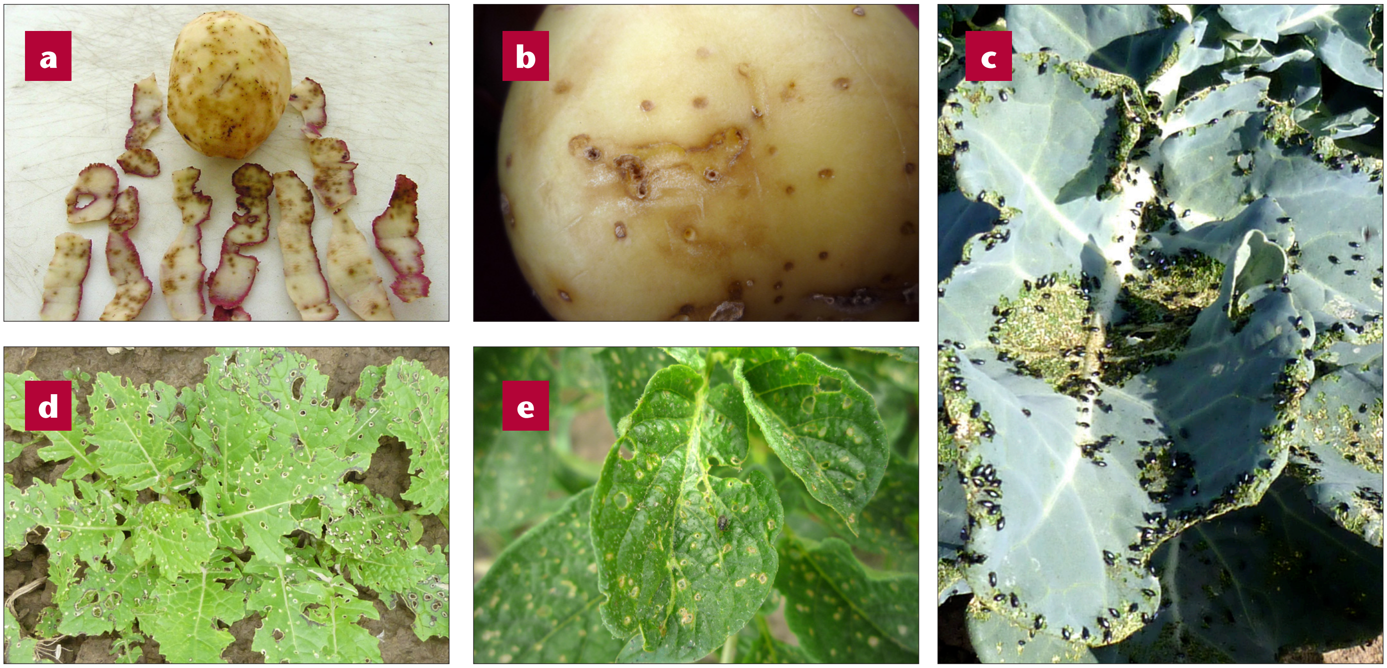

Figure 3. Tunneling damage to potato tuber caused by tuber flea beetle larvae (a), a closer view of tunnel and scar damage to potato tuber caused by tuber flea beetle larvae (b), pitting damage to broccoli leaves caused by adult crucifer flea beetles (c), shothole damage to mustard leaves caused by adult crucifer flea beetles (d), and shothole damage to potato leaves caused by adult tuber flea beetle (e). (Photos a, c, and e provided by G.H. Spitler, Washington State University)

fall: by planting earlier or later, you can avoid flea beetle larval feeding, adult emergence, and peak adult feeding activity. For example, to minimize the accumulation of damage from tuber flea beetle larvae, plant and harvest potatoes earlier in the season. Alternatively, plant potatoes later in the season when the temperatures are warmer to help plants outgrow the injury caused by flea beetle feeding. A good option for brassica crops is to plant in mid- to late July, which will reduce areas where overwintered flea beetles can feed and reproduce.

Trap crops. Trap crops lure flea beetles away from cash crops. Once flea beetles start to feed on the trap crop, you can kill them with a botanically-based insecticide or by tilling the infested trap crop into the ground. Chinese southern giant mustard (*Brassica juncea* var. *crispifolia*) is an example of a trap crop that has been used effectively in the United States to protect crucifer crops from flea beetle damage. In studies conducted at Washington State University (WSU), a diverse trap crop containing Pacific Gold mustard (*B. juncea*), Dwarf Essex rape (*B. napus*), and pac choi (*B. campestris* L. var. *chinensis*) successfully protected broccoli from the crucifer flea beetle. Diverse trap crop plantings combine plants that have different phenologies (life cycles which can be influenced by the environment, weather conditions, and nutrition), chemical profiles, and physical structures that make them more attractive to flea beetles.

It is important to note, however, that trap crops may not provide complete protection, especially during heavy pest infestations. Pest behavior and distribution in the field can also impact the success of trap crops. For example, tuber flea beetles have been shown to concentrate near the edges of potato trap crops and not move into the centers of these fields. Similarly, low densities of crucifer flea beetles have been shown to concentrate near the edges of broccoli crops, but will move into the centers of these fields as densities increase. The shape of a trap crop may influence such reactions. For example, a perimeter trap crop (vs. one planted only along one side of a cash crop) creates a barrier around the entire border of a cash crop, and thus may be more effective if flea beetles concentrate around field edges (see below for details).

Installation. Plant or transplant the trap crop before the cash crop to provide a food source for the pest insects. To control the crucifer flea beetle, plant trap crops in early spring to protect a spring cash crop and/or early fall to protect a cash crop that will be harvested later in the season. To control the tuber flea beetle and western potato flea beetle, plant trap crops in early spring. Trap crop plantings can vary in size and shape (Figs. 4 and 5), but in general the area planted with a trap crop should be 10% of your total crop area.

Follow these steps to install a trap crop:

1. Decide which trap crop plant or mixture of plants you wish to use. For example, a perimeter trap crop of collard has been shown to protect broccoli from crucifer flea beetle feeding.
2. Determine where you will plant the trap crop and in what arrangement. Two common layouts (Figs. 6 and 7) are as follows:

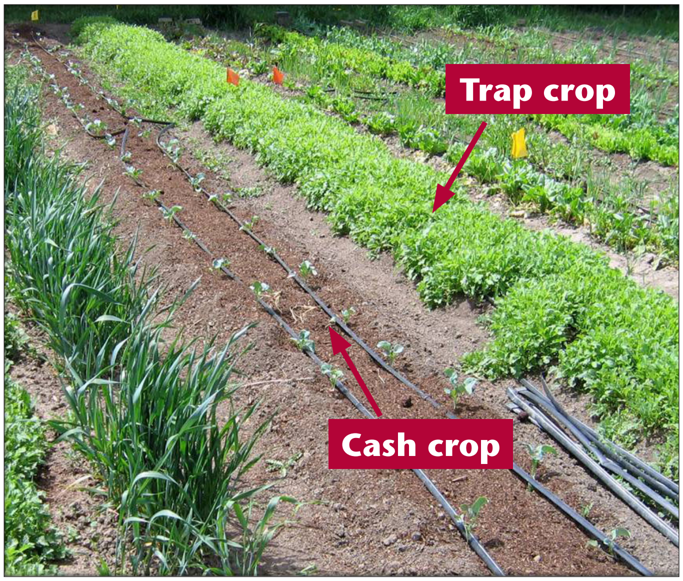

Figure 4. A mustard trap crop next to one row of broccoli seedlings.

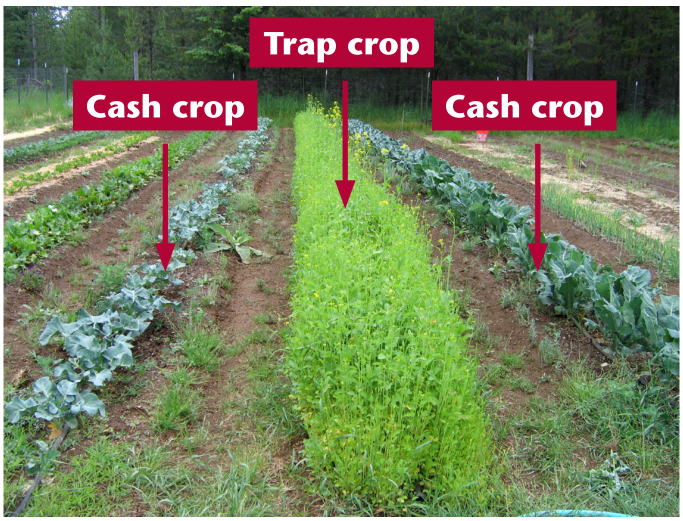

Figure 5. A mustard trap crop in between two rows of broccoli.

3. Determine how close you want the trap crop located to the cash crop based on how much area you have to work with. For example, the mustard/rape/pac choi trap crop at WSU equally protected broccoli whether planted 1.6 feet away or 36 feet away.
4. Transplant or direct seed the trap crop.
5. Wait until the trap crop is established (2–4 weeks depending on crop growth and variety) and transplant or direct seed the cash crop into the remaining open sections of the field.
6. Depending on the trap crop, maintain the area by weeding, trimming or mowing to remove flowers and prevent seed set and plant senescence (death).
7. Once you find flea beetles in the trap crop, do one of the following:


Figure 6. A strip trap crop is planted along one side of a field.

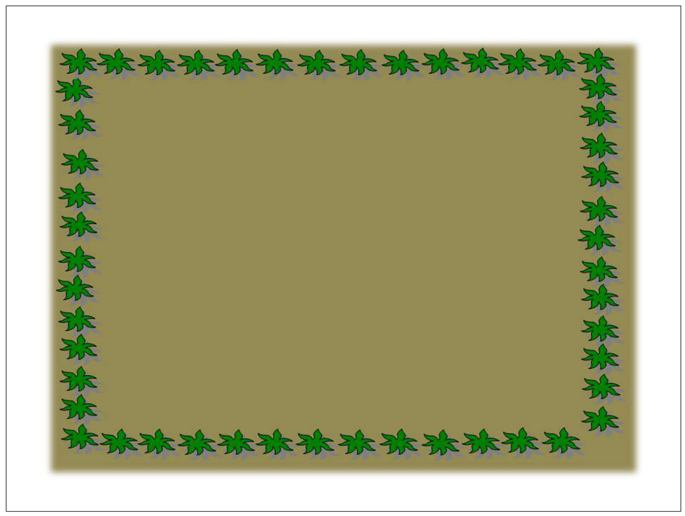
Figure 7. A perimeter trap crop is planted around a field border.

- Spray the trap crop with an approved organic insecticide.[1]
- Physically remove and then kill the insects (e.g., handpick or use an insect vacuum to suck them off the trap crop, followed by placement in a freezer).[2]
- Till the trap crop into the ground.

Companion plants. Companion plants can confuse, repel, or block insect pests from finding host plants.

[1]The WSU trap crop of mustard, rape, and pac choi protected broccoli from flea beetles whether the trap crop was sprayed with an insecticide or left unsprayed.

[2]It is not always necessary to remove the pest from the trap crop for the trap crop to be effective (e.g., when the pest population is very low). Also, keep in mind that the highly mobile nature of flea beetles means they may move back into the cash crop. This can happen if the trap crop becomes less attractive to the pest due to plant senescence, seed set, or environmental stressors such as lack of water or high temperatures. If flea beetles are killed in the trap crop, they do not need to be removed.

Bunching green onions, dill, and marigolds are a few examples of companion crops that have been used for flea beetle management. By intercropping or planting companion plants next to host plants, you will create a more diverse planting that makes the host plants less apparent to the pest. Companion plants can also be used together with trap crops to increase pest control: the companion plants repel flea beetles from the host plants, while the trap crop attracts the flea beetles.

Mulches. Living mulches are crops that can be interplanted with or undersown in a cash crop to interfere with the flea beetle's ability to locate host plants. Just as with companion plants, living mulches will obscure host plants from flea beetles. Living mulches also provide habitat for ground-dwelling beneficial insects such as predatory ground beetles which can feed on the larval and adult stages of flea beetles.

Although little research has been done to identify specific living mulches and ground covers that are effective in flea beetle suppression, in general, living mulches can consist of legumes such as clover and vetch. It is important to note that living mulches can compete with cash crops for nutrients, space, and water, sometimes reducing yield, and thus it may be best to plant living mulches in alleyways between crop beds.

Non-living mulches can be used to interfere with or inhibit flea beetle oviposition (i.e., egg laying). Researchers at Oregon State University saw a moderate improvement in flea beetle control when barley straw mulch or municipal yard waste large leaf mulch was applied in organic potato fields of at least 150 square feet.

Sanitation. Sanitation practices such as mowing and tilling weeds (especially early in the season) and removing plant debris within cash crops can reduce flea beetle populations by minimizing food sources and overwintering habitat. Particularly troublesome weeds are volunteer host plants such as weedy mustards.

Mechanical and Physical

Floating row cover. Floating row covers are physical barriers placed over cash crops to exclude flea beetles. Install the floating row cover over the crop before flea beetles are in the area, and secure well on all sides. See the Washington State University Extension publication *How to Install a Floating Row Cover* (FS089E) for details. If flea beetles get under the row cover, they can feed without interruption from natural enemies or adverse environmental factors.

Sticky traps. Yellow sticky traps and sticky tape will physically capture flea beetles, but also beneficial insects. Place sticky traps around the host plants and replace when they are full or no longer sticky (e.g., blowing soil has covered them). Sticky traps are most effective as part of scouting programs to monitor and detect flea beetle populations.

Biological

Parasites and predators. A native parasitoid wasp, *Microctonus vittatae*, is found throughout the Pacific Northwest and can kill adult crucifer flea beetles, although the rate of parasitization is low. Generalist predators such as lacewing larvae (*Chrysopa* spp.), big eyed bugs (*Geocoris* spp.), and damsel bugs (*Nabis* spp.) have also been known to feed on adult stages of flea beetles. Grow flowering plants such as anise, dill, chamomile, marigold, or clover around the host plants to enhance floral resources and encourage the native parasitic wasp and other generalist predators. For more information on using flowering plants to encourage beneficial insects, see the Pacific Northwest Extension publication *Encouraging Beneficial Insects in Your Garden* (PNW0550) and the U.S. Department of Agriculture publication *Plants for Pollinators in Oregon*.

Entomopathogenic nematodes. Entomopathogenic nematodes are soil-dwelling parasitic worms that kill insects. Many insects that have a life cycle in the soil, including flea beetles, are susceptible to biological control organisms. Entomopathogenic nematodes in the families Steinernematidae and Heterorhabditidae can attack the larval stage of flea beetles, thereby reducing the emerging population. Furthermore, the nematode species *Steinernema carpocapsae* has been demonstrated to decrease damage caused by flea beetle larvae in potatoes. See the Pacific Northwest Extension publication *Using Entomopathogenic Nematodes for Crop Insect Pest Control* (PNW544) for more information on using entomopathogenic nematodes as biological control organisms.

Biological Pesticides

Fungal pathogens. *Beauvaria bassiana* is a fungus commonly found in many soils, and it causes a disease in insects known as white muscadine that has been shown to reduce flea beetle populations. When insects come into contact with *B. bassiana* fungal spores, either by sprayed droplets or exposure to a treated surface, the spores attach to the insect, germinate, and penetrate the insect's body. The fungus releases toxins that liquefy the insides of the insect, creating a food source for the fungus and subsequently killing the insect. The *B. bassiana* strains GHA and ATCC 74040 are effective at controlling flea beetles, and some formulations are organically approved and can be purchased commercially. It is most effective to apply *B. bassiana* in the evenings because sunlight can kill these spores.

Chemical Pesticides

There are several commercial insecticides labeled to control flea beetles and allowed for use in certified organic production. However, keep in mind that even natural insecticides can have broad-spectrum actions that kill beneficial insects in addition to your targeted pest. Always consult the label for specific usage before applying a pesticide. See the *Pacific Northwest Insect Management Handbook* for current information regarding chemical pesticides.

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All photos are by J.E. Parker unless otherwise noted.

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