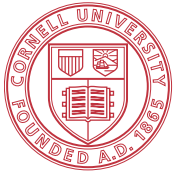


VEGETABLE CROPS



Cornell University



Flea Beetle Pests of Vegetables

Mike Hoffmann and Rick Hoebeke

Department of Entomology, Cornell University, Ithaca, NY

and Helene Dillard

Department of Plant Pathology and Plant Microbe Biology, Cornell University, New York State Agricultural Research Station, Geneva, NY

Introduction

Flea beetles are common pests and frequently do serious damage to vegetable crops. Excessive feeding damage by flea beetles can stress and kill young plants. On maturing crops, feeding may scar leaves or fruit, resulting in cosmetic damage and reduced crop value at harvest. Some species are important vectors of crop disease. Flea beetles rapidly colonize crops at the onset of warm spring weather and serious damage can occur quickly. Species occurring in the northeastern United States include the corn, potato, crucifer, eggplant, striped, horseradish, palestriped, and tobacco flea beetle. Some of these are consistent pests, whereas others only occasionally cause serious damage. As the names imply, there is a certain degree of crop specificity associated with the various species of flea beetles, although many feed on several crops and numerous weeds. On occasion, other species of flea beetles may be present and cause damage to vegetables.

Appearance

Flea beetles are small (<6.0mm [1/4 inch] in length), elongate, oval-shaped beetles, often shiny and dark colored. Some species have stripes. They are very active and will jump or fly when disturbed, thus the name “flea” beetles. Jumping is facilitated by their enlarged hind legs (femurs). The antennae are typically one-third to one-half the length of the body. Flea beetle larvae are small, whitish, delicate, and cylindrical. They are inconspicuous in the soil, where they feed on the roots of host plants. They possess three pairs of tiny legs and a hardened, brownish head.

Life Cycle and Seasonal Patterns

The life cycle and seasonal patterns of the various species of flea beetles are fairly similar. Flea beetles overwinter as adults in protected areas such as along fencerows, at the edges of woods, and under leaf litter and other plant debris. Some may overwinter in field soil following harvest. With warmer temperatures (>50°F) in late April and May, flea beetles become active and begin to leave their overwintering sites and seek acceptable host plants. This early-season dispersal may occur over several weeks, and because flea beetles are excellent fliers dispersal may be over considerable distances.

Typically, the only acceptable hosts available to flea beetles dispersing from overwintering sites are weeds, as crops are not yet available. Once crops begin to emerge or are transplanted, however, they can be rapidly colonized by flea beetles. Female flea beetles lay their eggs in or on the soil near host crop plants. The crucifer flea beetle also lays eggs in gnawed-out areas of roots, and the horseradish and spinach flea beetle lay their eggs in clusters on leaves. Egg deposition may extend over several weeks. Eggs hatch in 7 to 10 days. Adult flea beetles are fairly long-lived, but generally they die off after the reproductive period (mating and egg laying). Thus, all the beetles that colonize fields early in the season ultimately die and their progeny (second brood) appear later in the season. Some species may have more than one generation (egg to egg) per year, and there may be considerable overlap between generations resulting in adults being present most of the season.

Flea beetle larvae feed on roots and other underground plant structures. Larvae of the horseradish and spinach flea beetle feed on leaves. Larvae pass through several stages (instars), increasing in size with each stage. Pupation occurs in the soil. The duration of the immature stages varies among species of flea beetles, but typically development from egg to adult takes 6 to 10 weeks. With higher temperatures the rate of development is increased and additional generations may occur during the summer. Second- and third-brood adults feed and damage mid- to late-season crops. Beetles are most active and damaging under sunny, hot, and dry conditions. Late in the summer and early fall, adult flea beetles seek out overwintering sites. They remain there until the next spring.

Common Species

The following describes key characteristics of the species of flea beetles that occur in vegetables, their crop and weed hosts, and the damage they cause. All flea beetles are members of the insect order Coleoptera and the family Chrysomelidae. Some species of flea beetles feed on a wide array of host plants, whereas others attack only one plant or a group of closely related host plants.



Figure 1. Corn flea beetle. Photo by J. Ogradnick, NYSAES Photo.



Figure 2. Corn flea beetle feeding. Photo by M. Hoffmann.



Figure 3. Sweet corn showing symptoms of Stewart's wilt. Photo by M. Hoffmann.

CORN FLEA BEETLE, *CHAETOCNEMA PULICARIA*

This flea beetle is bronze-black, 1.6 mm (1/16 inch) in length, and occurs across much of the eastern United States (Fig. 1). They are good fliers and disperse over considerable distances in the spring, rapidly colonizing entire fields of sweet corn. Corn flea beetle activity begins in May and has been recorded in fields even before the sweet corn emerges. Second-brood adults are present in sweet corn from July through harvest.

Vegetable host

Sweet corn

Other hosts

Many grasses, field corn, oats, sorghum, sweet potato, morning glory, and nettle

Damage

Feeding by adults results in short, shallow channels in corn leaves (Fig. 2). Under very high populations, emerging corn seedlings can be severely damaged or killed by heavy feeding. Young corn plants severely attacked by corn flea beetle will have a bleached appearance.

The greatest damage from corn flea beetle occurs when it vectors the bacterium, *Erwinia stewartii*, which causes Stewart's wilt disease in sweet corn. Some beetles carry the Stewart's wilt pathogen in their gut and vector the bacterium to sweet corn when they infest fields. Secondary infection and spread of the disease occurs as beetles feed on infected corn plants and disperse throughout the field. The bacterium is carried by the flea beetles for the rest of their life. However, no transovarial (by way of egg) bacterial transmission has been observed. Once a plant is infected, the bacterial pathogen multiplies in the vascular tissue, restricting flow of nutrients and moisture and producing conspicuous pale green to yellow to brown stripes or streaks with wavy or irregular margins on the leaves and stalk (Fig. 3). Stems clogged with the multiplying bacteria show a typical discoloration when cut in cross section. Wilt infections cause reduction of yield due to death or stunting of infected seedlings. Seedlings that survive early infections remain stunted, tassel prematurely, and

frequently produce no ears or ears that are unmarketable (Fig. 4). In general, corn that is "knee high" or taller and infected with Stewart's wilt at this stage or later will not be adversely affected by the disease. Disease severity is aggravated by high temperatures, which encourages faster symptom development and movement of the bacteria through the infected plants. The severity of the disease is increased when plants are under moisture stress.

Predicting risk of wilt

The threat of Stewart's wilt to susceptible sweet corn is greatly reduced or even eliminated when winters are cold, as low temperatures cause high corn flea beetle mortality. A wilt index has been developed that uses the sum of the mean monthly temperatures for December, January, and February to predict the severity of Stewart's wilt for the following season. The wilt index (likelihood of wilt problems) is as follows: >100 = severe; 90-100 = moderate to severe; 85-90 = moderate; 80-85 = light; below 80 = absent. A series of warm winters and low beetle mortality results in increasing populations of corn flea beetles. In contrast, a very cold winter (wilt index \geq 80) can result in low populations for the following two to three years.

CRUCIFER FLEA BEETLE (OR EUROPEAN CRUCIFER FLEA BEETLE), *PHYLLOTRETA CRUCIFERAE*

STRIPED FLEA BEETLE, *PHYLLOTRETA STRIOLATA*

These two species are fairly similar in habits and crops attacked. The crucifer flea beetle is bluish or greenish black and 2 mm (1/12 inch) long (Fig. 5). The striped flea beetle is 2 mm (1/12 inch) long, shiny black with crooked yellow stripes on the back (Fig. 6). Both species were accidentally introduced from Europe. The crucifer flea beetle is the most common flea beetle on crucifers. The striped flea beetle is a common vegetable pest with a relatively wide host range. Both species are attracted to and stimulated to feed on cruciferous plants by the mustard oils (glucosinolates) present in the plants. In the spring, beetles initially feed on cruciferous and other weeds, then disperse to crops where they feed and lay eggs. Second-brood beetles emerge from mid-June to mid-August.



Figure 4. Ears of corn from plants infected with Stewart's wilt. Photo by M. Hoffmann.



Figure 5. Crucifer flea beetle. Photo by J. Ogradnick, NYSAES Photo.



Figure 6. Striped flea beetle. Photo by J. Ogradnick, NYSAES Photo.



Figure 7. Flea beetle damage on crucifer. Photo by M. Hoffmann.



Figure 8. Potato flea beetle. Photo by J. Clark, University of California Statewide IPM Project.



Figure 9. Flea beetle damage to potato. Photo by M. Hoffmann.

Vegetable hosts

Both species feed on cruciferous crops such as broccoli, cabbage, brussels sprouts, rutabagas, turnip, kale, horseradish, and radish. Striped flea beetle has been reported to also feed on cucumber, squash, pumpkin, tomato, and potato.

Other hosts

Crucifer flea beetle—wild mustard, cruciferous weeds, sweet alyssum

Striped flea beetle—rape, fall rye, garden flowers

Damage

The greatest damage from these two species occurs when overwintered adults attack emerging plants and new transplants early in the season. Direct-seeded crops are especially vulnerable. Feeding on cotyledons and small leaves results in small round holes giving a “shothole” appearance (Fig. 7). Beetle damage may kill young plants or delay plant development and result in lower yields. Once plants have >5 leaves, they can compensate for damage and there is less risk of yield loss. Beetles also may feed on the stem below the ground, killing young seedlings. Feeding on older plants may be restricted to leaf edges, resulting in browning and curling of leaves. Damage to broccoli and cabbage heads can significantly reduce crop quality and marketability, and feeding on radish and rutabaga may result in cosmetic damage.

In addition to direct feeding damage, the adult crucifer flea beetle is reported to vector the bacterium that causes black rot and the fungus that causes *Alternaria* leaf spot. In both disease situations, the pathogens may be seed- or soilborne. The flea beetle becomes contaminated with inoculum as it feeds on cruciferous plants and spreads the pathogens to healthy tissue. Spores of the fungal pathogen have been observed microscopically on the surface of flea beetle bodies and within flea beetle feces.

POTATO FLEA BEETLE, *EPITRIX CUCUMERIS*

The potato flea beetle is 1.6mm (1/16 inch) long, shiny, and black or mahogany brown, with yellow brown legs and brown antennae (Fig. 8). It is a conspicuous and common flea beetle on potato but generally is not a serious pest. Adults overwinter near fields that were planted to potatoes the previous season. Second-brood adults usually appear in July and August.

Vegetable hosts

Primarily potato, but also eggplant, tomato, pepper, turnip, beans, radish, and cucurbits

Other hosts

Feeds on a variety of herbaceous plants, including nightshade, ground cherry, and horse nettle

Damage

Adults attack young plants as they emerge early in the season. Second-brood adults attack potato foliage later in the season. The damage to leaves results in a “shothole” appearance (Fig.

9). At 30-40 holes/leaf the functional surface of the leaves is reduced and can result in plant death under hot and dry weather conditions. Larvae feed on roots and tubers causing shallow scars and fine tunneling, but such damage is typically removed when the potato is peeled. The potato flea beetle facilitates the spread of bacterial blight and spindle tuber disease in potatoes. Early-season infestations are usually controlled by insecticides used for control of Colorado potato beetle. Mid- to late-season infestations are typically more important.

TOBACCO FLEA BEETLE, *EPITRIX HIRTIPENNIS*

The tobacco flea beetle is 1.6 mm (1/16 inch) long, yellowish brown with a dark cloud across the back (Fig. 10). The antennae and legs are light brown. It is an occasional pest in vegetables.

Vegetable hosts

Tomato, potato, eggplant, pepper

Other hosts

Nightshade, ground cherry, horsenettle, and others

Damage

Feeding damage appears as shotholes (Fig. 9) and leaves with excessive damage may desiccate and die. Leaf damage can continue all season long. Larvae feed on roots and may bore into stems.

HORSERADISH FLEA BEETLE, *PHYLLOTRETA ARMORACIAE*

The horseradish flea beetle can be distinguished from most other flea beetle pests of vegetables by the presence of straight yellowish stripes on the wings (Fig. 11) and its relatively large size (3.2 mm [1/8 inch] long). This species was accidentally introduced from Europe and is a sporadic pest. Overwintered adults initially feed on cruciferous weeds, then move to crops as they become available. Second-brood adults are present from July to the end of the season.

Vegetable hosts

This species is relatively specific to horseradish but also has been observed damaging radish, cabbage, and turnip.

Other hosts

Wild mustard

Damage

Feeding on young plants results in a “shothole” appearance. Extensive feeding damage may result in delayed plant growth and reduced yields. Feeding damage by adults late in the season may result in reduced yields of horseradish. Larvae feed within (mine) the petioles and midribs of leaves.

PALESTRIPED FLEA BEETLE, *SYSTEMA BLANCLA*

This is a native species with broad distribution across temperate North America. The margins of wings are pale brown to black, with a broad white stripe down the middle of each wing. It is 4.2 mm (1/6 inch) in length.



Figure 10. Tobacco flea beetle. Photo by J. Clark, University of California Statewide IPM Project.



Figure 11. Horseradish flea beetle. Photo by J. Ogradnick, NYSAES Photo.



Figure 12. Eggplant flea beetle. Photo by J. Ogradnick, NYSAES Photo.

Vegetable hosts

Pepper, cucurbits, sweet potato, potato, peas, beans, beets, tomato, corn, turnip, pumpkin, melon, eggplant, and others

Other hosts

Strawberry, alfalfa, pigweed, lambsquarters, purslane, ragweed, cocklebur, wild sunflower, and others. Larvae appear to prefer lambsquarters and shepherd's purse.

Damage

This species prefers to feed on weeds, but early in the season when weeds are small, it will attack available crops. Large populations will build up on weeds as the season progresses. Adults feed mostly from the underside of leaves. Severe damage results in leaves turning brown and dying. Larvae will feed on roots and seeds. They will damage corn seed, preventing germination.

SPINACH FLEA BEETLE, *DISONYCHA XANTHOMELAS*

The spinach flea beetle is 6.0 mm (1/4 inch) long. Wings are black with a green tinge; the thorax is orange and the head dark. This species becomes active in May and June, feeding initially on chickweed, lambsquarters, and other weeds, then moving into spinach and other crops. Females lay clusters of eggs on the leaves of host plants. The larvae, which are gray and grub-like and 6.0 mm (1/4 inch) long, feed on the undersides of leaves. Second-brood adults appear in late summer.

Vegetable hosts

Spinach, beet, swiss chard, horseradish

Other hosts

Chickweed, lambsquarters

Damage

Adults chew small holes or pits in leaves, which results in cosmetic damage that can reduce crop marketability. More severe damage can retard growth and reduce yield and heavy infestations can kill young plants. Rapid colonization of crops near harvest can result in major losses.

EGGPLANT FLEA BEETLE, *EPITRIX FUSCULA*

The eggplant flea beetle is uniformly black and 1.6 mm (1/16 inch) in length (Fig. 12). This species occurs in the northeastern United States but is more common in southern states. It has a relatively narrow host plant range.

Vegetable hosts

Eggplant, potato

Other hosts

Horsenettle, strawberry

Damage

Feeding damage appears as shotholes (Fig. 12) in leaves and greatest damage occurs early in the season. Leaves with excessive damage may desiccate and die, and young plants can be killed. Larvae may cause damage to potato tubers.

Management

SCOUTING FIELDS

Because of the potential for rapid invasion, fields need to be watched carefully when young. Scout two to three times per week at this stage. Sunny and calm days are best for estimating infestations, because beetles are active. Rain and cold can drive beetles into protective niches in the soil or under debris. Sample plants randomly from the field making sure the sampled area encompasses most of the field. Follow specific sampling guides for the particular vegetable crop being monitored. Because some species of flea beetles move in from the field edge, monitor field edges closely for initial infestations. Yellow or white sticky traps can be used to indicate the presence of flea beetles; however, by the time they appear on traps they are also apparent on the crop.

THRESHOLDS

Thresholds are available for some vegetables. Small plants are at greatest risk. As the crop develops, the decision to treat needs to be based on risk to quality and cosmetic considerations. If infestations exceed thresholds, apply an insecticide. Note that following a spray, fields may be reinfested, requiring additional treatments. Thresholds recommended for young plants in New York or the midwestern states (Foster and Flood 1995) are as follows:

Crucifers—crucifer and striped flea beetles: treat if at seedling stage (up to six true leaves) and one or more flea beetles/plant

Leafy vegetables in seedling stage—crucifer, spinach, and striped flea beetles: treat if beetles are common on most plants and defoliation >30%

Pepper and eggplant—eggplant, tobacco, palestriped, and potato flea beetles: treat if plant <3 inches tall and two flea beetles/plant; treat if 3-6 inches tall and four flea beetles/plant; treat if >6 inches tall and eight flea beetles/plant

Potato—potato flea beetle: treat if >50 flea beetles/25 sweeps

Tomato—palestriped and potato flea beetles: treat if >30% defoliation

Sweet corn (Stewart's wilt-susceptible varieties, less than "knee high")—corn flea beetles: treat if 6 or more corn flea beetles/100 plants.

CULTURAL CONTROLS

Control of volunteer crop plants and weeds in fields and along field edges is very important. These plants, especially early in the season, act as early food sources, shelters, and areas for reproduction. The most severe infestations may occur in fields that were previously weedy. Damage can be reduced by delaying planting to avoid the early-season flush of beetle activity and by using a higher seeding rate to compensate for potential stand loss. In areas with high risk from flea beetles, use transplants; do not direct seed. For some species of flea beetles that attack crucifers, research has shown that interplanting/companion planting with tomatoes, marigolds, or living mulches such as rye grass or clover can help reduce infestations, but these may compete with the crucifers and result in lower yields. Chemical stimuli from the interplanted nonhost plants apparently interferes with host finding by this species. Interplanting may work for other species of flea beetles but has not been as well researched.

Row covers also can provide relief for some vegetable crops but may increase the risk of disease and weed problems. Trap crops of highly preferred crucifers (glossy types or those with higher levels of mustard oils) can be used to detect early infestations and also are a potential means of aggregating flea beetles where they can be more efficiently controlled. Sprinkler irrigation has been used to drown flea beetles but must be done when beetles are very active. After harvest, destruction of crop residues and deep disking can help suppress overwintering populations.

In sweet corn, infestations of corn flea beetle apparently are not reduced by crop rotation. Studies indicated that the level of infestation in a particular field was not influenced by what was planted in that field the previous year. These same studies showed that fields planted midseason generally had lower beetle infestations than early- or late-planted fields. This is because during the susceptible stages of sweet corn development (up to knee high), most overwintered beetles have died off and their progeny are in the larval stage and not capable of vectoring Stewart's wilt from plant to plant. After this window of time the larvae emerge as adults and again vector the disease. Planting susceptible varieties midseason would subject them to less corn flea beetle pressure and thereby reduce the risk of Stewart's wilt.

VARIETAL RESISTANCE

There are differences in susceptibility to flea beetle attack and damage among the various types of vegetables. Under heavy infestations, however, most may be heavily damaged. For flea beetles attacking crucifers, cultivars with smooth and glossy leaves are preferred over those with rough or hairy surfaces. Likewise, crucifers with higher levels of mustard oils, such as arugula or mustard, may be preferred.

In sweet corn there is no known resistance to corn flea beetles, but using wilt-resistant varieties is the most effective means of controlling Stewart's wilt. Contact your local Cooperative Extension office or seed distributor for information on susceptibility ratings.

NATURAL CONTROLS

Reported natural enemies of adult flea beetles include predaceous stink bugs, field crickets, damsel bugs, lacewings, and collops beetles. However, they do not exert much effect on flea beetle infestations. Naturally occurring nematodes are known to attack adult flea beetles, infecting up to 18 percent. Some attempts have been made to control flea beetle larvae with applications of nematodes; however, the results have not been encouraging. Parasitoids, in particular *Macroctonus vittatae*, a braconid wasp,

help suppress the striped, crucifer, and possibly other species of flea beetles. The rate of parasitism is usually about 5 percent, but there are some records showing parasitism rates of 45 percent. It is widely distributed in the eastern United States. It kills beetles but also sterilizes female beetles while feeding and developing internally.

Environmental stresses can take their toll on flea beetles. Heavy rains, for example, have been reported to reduce flea beetle infestations. Cool and wet weather is detrimental because it results in low activity levels, less feeding, and slow emergence from hibernation. Extremely cold winters can cause mortality among overwintering populations of some species. This is well documented for corn flea beetle.

CHEMICAL CONTROL

Applications of most insecticides to the foliage are effective for controlling infestations of flea beetles. Multiple applications may be needed, however, as beetles can reinvade fields. Spot treat where infestations are localized. Treatments on warm, sunny, and calm days are best because of the higher level of flea beetle activity. Where appropriate, the use of soil-applied insecticides at planting can provide control. However, control may be variable, especially when adequate moisture is not available for uptake of the insecticide. Subsequent generations of flea beetles will not necessarily be controlled by soil insecticides applied to control first-generation beetles. Systemic insecticides applied at planting can reduce the incidence of Stewart's wilt in sweet corn.

OTHER REPORTED CONTROL TACTICS

Frequent cultivation has been reported to "drive" flea beetles off plants. Large numbers of flea beetles can be captured by attaching vertical sheets covered with insect-trapping sticker to the tractor cultivator so that the sheets drop between rows of crop and just above the ground. As the cultivator passes over the crop, flea beetles jump and are captured on the sticky surface. Likewise, a box with the inner walls coated with insect-trapping sticker can be passed over infested plants to capture flea beetles as they jump off plants.

References and additional reading

Foster, R., and B. Flood (eds.). 1995. *Vegetable insect management: with emphasis on the Midwest*. Willoughby, Ohio: Meister.

Howard, R.J., J. A. Garland, and W L. Seaman (eds). 1994. *Diseases and pests of vegetable crops in Canada*. Canadian Phytopathological Society and Entomological Society of Canada.