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EC89-1553 Insect Management Guide for Garden Vegetables

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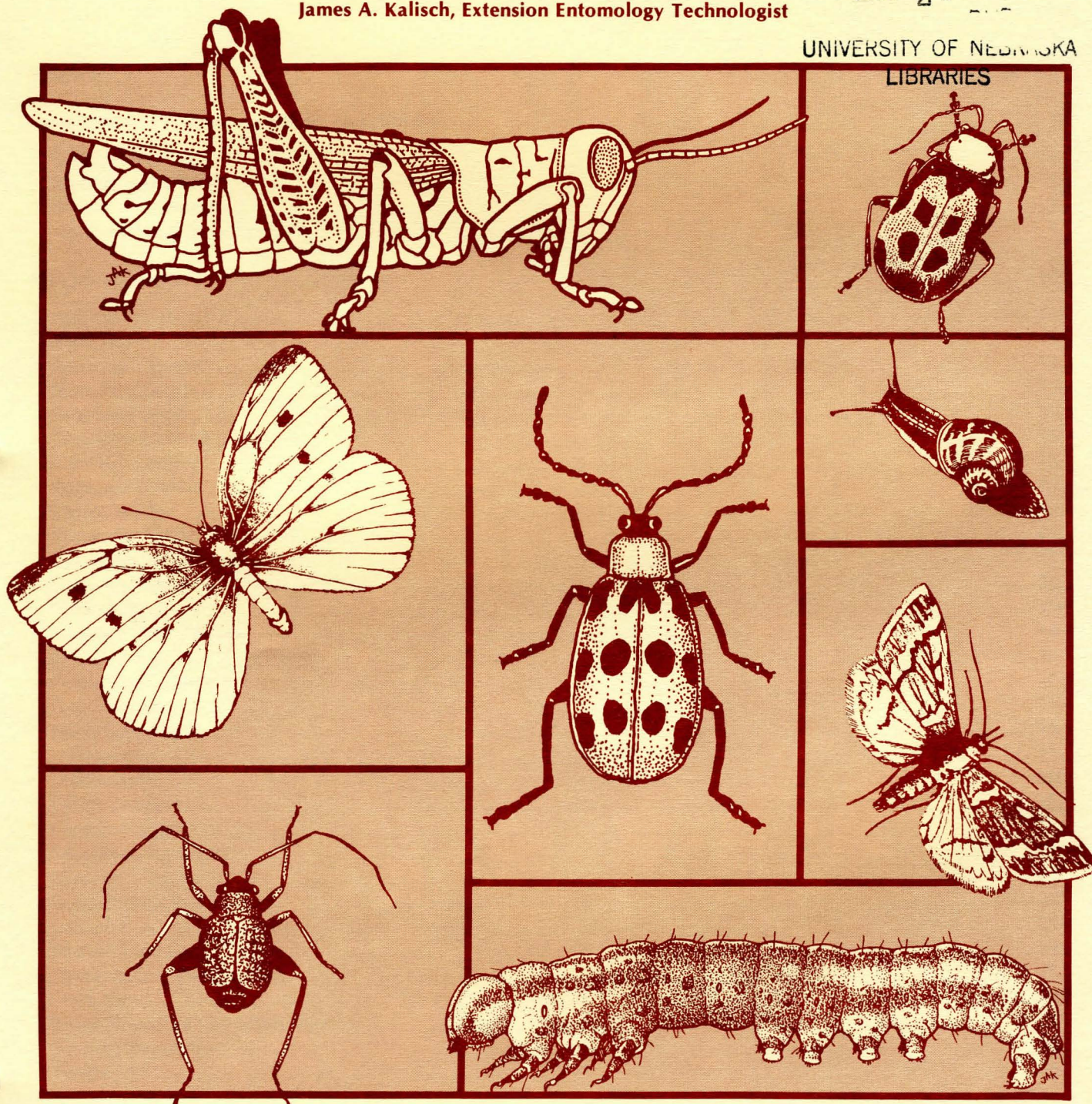
Insect Management Guide for Garden Vegetables

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Insect management recommendations in this guide are based on University of Nebraska research results, data from neighboring universities, USDA recommendations and previous experience. These suggestions are designed to guide Nebraska home gardeners in selecting an appropriate insect management program. The user of this information assumes all risks for personal injury or property damage.

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Insect Control Without Synthetic Insecticides

Cultural Methods

There are several approaches to managing insect pests in Nebraska. These include the use of cultural practices, resistant plant varieties, biological control and/or insecticides.

Before making a treatment decision, consider all appropriate management strategies. If insecticide use is indicated, consider its efficiency against the target pest or pest combination, label restrictions,

Cultural, mechanical and biological methods can be used to reduce insect damage to vegetables. More time usually is required and

Rotation of Plots. Rotating the location in which vegetables are planted does not reduce the incidence of foliar feeding insects, but may reduce damage caused by soil inhabiting pests such as wireworms, white grubs, seedcorn maggots, seedcorn beetles, corn rootworms, millipedes and some cutworms.

Avoid planting root crops into garden areas that were infested with soil insects the previous year, or into plots that were in sod, or noncultivated soil the past year.

Mulches. Do not use heavy mulches during the growing season. Thick mulches of plant materials can encourage the development of potentially damaging pests such as millipedes, sowbugs and cutworms. Mulch with plastic film, straw or newspapers to conserve moisture.

Apply plant residues and compost to the garden in the fall and spade into the soil. Increasing the organic content of soils helps retain moisture and improve fertility.

Resistant Varieties. Very few varieties of vegetables are resistant to insect attack. Some are more tolerant than others, however, and may be identified as such on the seed package label. Cucumbers and cantaloupes, for example, are difficult to protect from cucumber beetles that carry the bacterial wilt organism. Some varieties may be more tolerant to bacterial wilt, and

formulation of the pesticide, cost, safety to non-target species (including humans), environmental conditions at the time of application and other factors.

IMPORTANT: Subscribe to the *Insect, Plant Disease, and Weed Science Newsletter* for the latest pest management recommendations, changes in pesticide registrations and updates on the current status of insect pests.

growers may experience some loss in quality and reduction in yields when "outbreaks" of certain insects occur.

these should be planted.

Fertility and Water. Fertilize and water well to encourage healthy, vigorous growth. Although these practices do not prevent insects, they tend to promote healthier growth and a more vigorous plant, better able to tolerate pest damage.

Interplantings. Interplantings have not been proven to repel insects. The practice will, however, provide some isolation of infestations, and can reduce the spread of damage. Isolated infestations generally are easier to manage.

Sanitation. Many insects (and diseases) are capable of overwintering in or on plant residues in the garden. Overwintering forms may be eggs on plants, adults in stems or under crop residues, or larvae or pupae in the soil. After frost has killed the plants or when they have finished producing, remove the plants and put them on the compost pile, or spade them into the soil later in the fall.

Cultivation. Keep gardens as free of weeds as possible. Some weeds serve as a reservoir for insects such as flea beetles, spinach leafminers and aphids, that later move to garden plants. Regular cultivation exposes soil insects to predators, parasites and weather. Plow or spade gardens in the fall to incorporate compost into the soil and to expose soil pests.

Mechanical control methods are used to prevent insects from infesting plants or to physically remove them after they are present.

Preventative Devices. Cardboard or metal collars around transplants reduce the risk of cutworm and millipede damage. Light reflection by aluminum foil on the soil along rows of vegetables tends to repel aphids. Floating row covers of lightweight, fine-meshed fabric can be draped loosely over crop rows and anchored to the soil at the edges. The small mesh size excludes nearly all insects the size of aphids or larger. These row covers also extend the growing season and moderate harsh summer temperatures.

For crops that require insect pollination (e.g., squashes, cucumbers, melons) or that benefit from insect pollination (e.g., eggplants, lima beans, okra, peppers), remove row covers once flowering begins. Metal screens or cold frames used to cover small areas of the garden exclude many harmful insects, as well as birds and rabbits.

Biological control is defined as using or manipulating one living organism to control another. Nature provides many effective biological control agents.

The use of microorganisms that cause insect diseases are being developed, and a few are highly effective. Only one, *Bacillus thuringiensis*, is available for the home gardener as a control of certain caterpillar and beetle pests.

Bacillus thuringiensis. Commonly called "B.t.," *B. thuringiensis* is marketed under the trade names Dipel, Thuricide and others. It is a spore formulation of a bacterium that can be mass-produced.

When certain species of insects ingest the disease spores, the resulting infection in the digestive tract causes the insects to stop feeding, become sick and die in four to seven days. Until recently, control has been limited only to caterpillars of some butterflies and moths, and mosquito larvae, but strains of *B.*

Syringing. A stream of cold water from a garden hose helps reduce infestations of aphids and spider mites. Water pressure usually is sufficient to dislodge small, soft-bodied insects.

Syringing must be carried out frequently, as it has little effect on eggs, and will not prevent some insects and mites from crawling back onto plants.

Hand-picking. It's easy to locate larger or more colorful insects and eggs and remove them by hand-picking or dislodging them into a can containing a small amount of water and detergent. Hornworms are located on tomatoes by watching for damage to leaves or the presence of fecal pellets below the plants. They can be picked off and squashed or otherwise destroyed.

Eggs of potato beetles, squash bugs and cabbageworms can be found and smashed or scraped off. Hand-picking requires considerable time, however, and may not be feasible for large gardens.

thuringiensis now have been developed for certain beetles such as the Colorado potato beetle. B.t. is especially useful for control of cabbageworms and a few other species of caterpillars that damage garden crops.

Beneficial Insects and Mites.

Natural populations of predators (e.g., lady beetles, lacewings, syrphid flies, preying mantids, wasps, predaceous mites) and parasites (e.g., wasps, tachinid flies, nematodes) are valuable in reducing infestations of garden pests. See *Figure 1* for examples of common beneficial insects.

Usually, some level of pest infestation or damage must be tolerated to attract and maintain natural enemy populations. Should pest control be necessary, try to select a management strategy to conserve or minimize injury to beneficials, while still attaining satisfactory control of the target pest.

Mechanical Control

Biological Methods

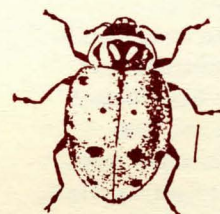
Several species of beneficial insects are mass-reared and can be purchased from commercial suppliers for release in home gardens. Generally, this method is risky in terms of the benefit it may provide. Success requires knowledge of predator/prey relationships and parasite/host biology, a good sense of timing and careful management.

For example, if an insufficient aphid infestation is present during mass release of lady beetles, the beetles fly elsewhere. In most cases, control of a pest by mass release of a predator or parasite is a much slower process than expected, and

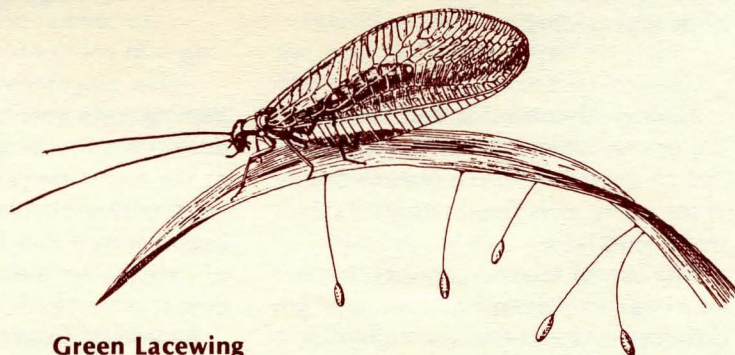
can lead to disappointment. It is far less costly and much more practical to conserve naturally-existing enemy populations through wise pest management practices.

Birds. Attract insect-eating birds to garden areas by planting trees and shrubs that furnish cover and berries for food. Feeding birds during the spring and summer tends to keep them in the neighborhood. Realize, however, that some species of birds are destructive to gardens, especially to berries, fruits and onions! These species may do more harm than good.

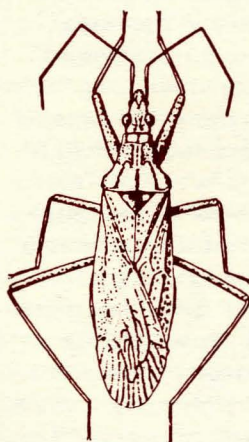
Figure 1.
Common beneficial insects



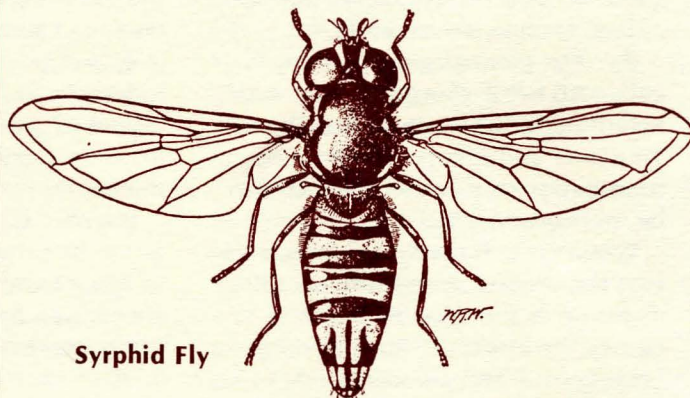
Lady Beetle



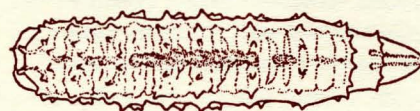
Green Lacewing

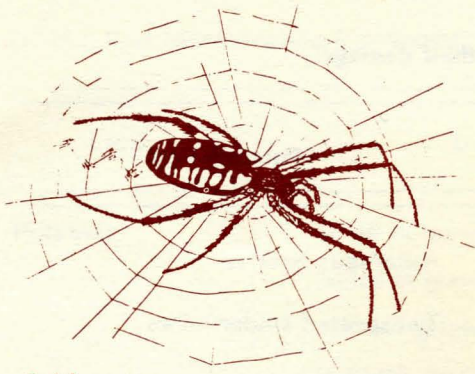


Damsel Bug



Syrphid Fly

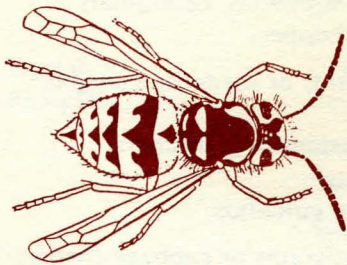




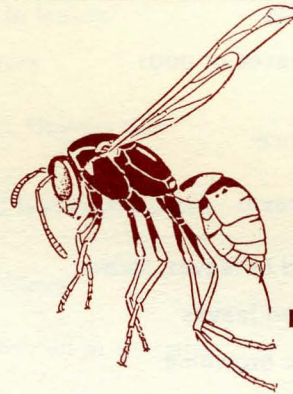
Spider



Praying Mantid



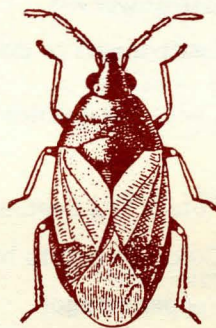
Yellowjacket



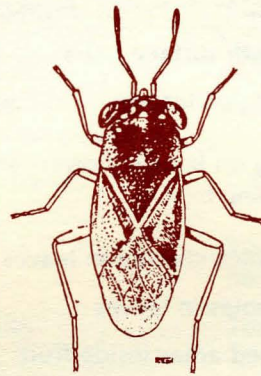
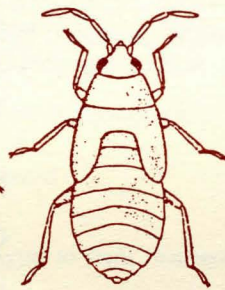
Paper Wasp



Ground Beetle



Minute Pirate Bug



Big-Eyed Bug



Parasitic Wasps

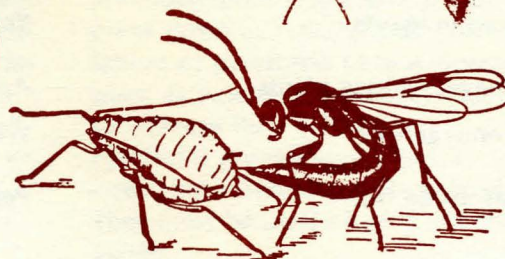
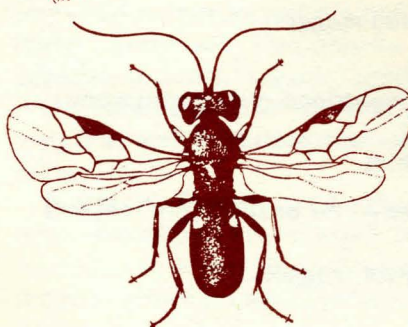
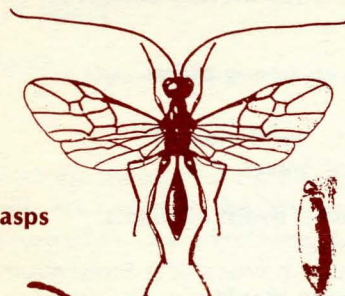


Table I. Pest Identification. How to identify garden vegetable pests and their damage

Crop	Damage Observed	Possible Pest
Asparagus	Spears or leaves chewed	Asparagus beetles
Beans	Light colored stippling, yellowing of leaves or webbing on undersides of leaves	Twospotted spider mites
	Stunted plants, leaf yellowing, crinkling or browning	Aphids or leafhoppers
	Holes chewed in leaves or pods	Bean leaf beetles, caterpillars or grasshoppers
	Poor plant emergence	Wireworms or seedcorn maggots
Beets	Blotchy mines in leaves	Beet or spinach leafminers
Cabbage, Broccoli, Brussels sprouts, Cauliflower, Kale, Kohlrabi	Small holes chewed in leaves, stems	Cabbage curculios
	Leaf chewing, ragged leaves	Cabbageworms or cabbage loopers
	Leaves yellowing or browning	Aphids or Harlequin bugs
	Discolored leaves with corky ridges	Thrips
Carrots	Roots with surface scars	Carrot weevils
	Yellowing of leaves	Leafhoppers or disease
Cucumber, Melons	Chewing on leaves, flowers and developing fruit	Cucumber beetles
Eggplant	Small holes chewed in leaves	Potato flea beetles
	Larger holes in leaves	Colorado potato beetles
	Blackened areas inside fruit	Pepper maggot
Leaf Lettuce	Yellowing, browning of leaves	Aphids or leafhoppers
	White flecks, discoloration on leaves	Garden fleahoppers or tarnished plant bugs
	Holes in leaves, young plants cut	Caterpillars or cutworms
Onions	White streaks, "sand-blasted" appearance of leaves	Onion thrips
	Yellowed leaves, death of plants, bacterial soft rot	Onion maggots
	Holes chewed in leaves	Yellowstriped or fall armyworms
Peas	Yellowing leaves, wilting plants	Aphids
	Poor plant emergence	Wireworms or seed corn maggots
Peppers	Fouled areas inside fruit	Pepper maggots

Table I. Pest Identification (continued).

Crop	Damage Observed	Possible Pest
Potatoes	Small holes or pits in leaves	Potato flea beetles
	Holes in leaves, defoliation	Colorado potato beetles
	Yellowing leaves, wilting plants	Aphids or European corn borers
	Purplish, curled leaves	Leafhoppers
Spinach, Swiss Chard	Blotch-like mines in leaves	Spinach leafminers
	Small holes in leaves	Spinach flea beetles
Squash, Pumpkins	Chewing on leaves, flowers and developing fruit	Cucumber beetles
	Wilted, blackened leaves, shrunken fruit	Squash bugs
	Sudden wilting of vines	Squash vine borers
Sweet Corn	Leaves severely chewed at margins	Armyworms or grasshoppers
	Chewed ear tips	Corn earworms
	Stalk breakage, poor ear development	European corn borers
	Young plants wilted	Stalk borers or black cutworms
	Light colored stripping, yellowing of leaves or webbing on undersides of leaves	Spider mites
	Poor plant emergence, reduced stand	Wireworms
Tomatoes	Leaves chewed	Variegated cutworms or tomato hornworms
	Holes chewed in fruit, fouled with excrement	Tomato fruitworms
	Plants yellowing or wilting	Aphids
	Light colored stippling on leaves and fruit, yellowing of plants	Twospotted spider mites
	Sudden wilting of plants	Stalk borers

The following chemicals have insecticidal properties but are not synthetic insecticides. They may be acceptable to some "organic" gardeners. **All are destructive to beneficial insects as well as certain noxious insects.**

Pyrethrins. Pyrethrins are refined from natural pyrethrum, which is extracted from a species of chrysanthemum grown primarily in Kenya, Africa.

Synthetic pyrethrins, called pyrethroids, are based on the chemical structure of natural pyrethrins, but are much more stable and do not break down as rapidly. Many formulations of pyrethrins have a synergist (such as piperonyl butoxide) added to increase their efficiency. Pyrethrins provide quick knock-down, but residual activity is brief. They must be used often if insects persist.

**Non-Synthetic
Insecticides**

Pest Identification

These chemicals are effective against most garden pests, especially soft-bodied forms, since they kill by absorption through the insect's skin. Pyrethrins are not effective against spider mites.

Rotenone. Most rotenone is produced from roots of the derris plant that grows in South America. The product is highly toxic to cold-blooded animals, but only slightly toxic to most warm-blooded animals. Rotenone is the most effective and readily available of the non-synthetic insecticides. It can be purchased as a powder and used as either a dust or a spray. Rotenone is effective for most garden insects, but not for spider mites. The residual activity is very short.

Sulfur. Finely-ground sulfur can be used as either a dust or a spray. If sprays are preferred, be certain the formulation used is intended for spraying.

Sulfur can be used for the control of spider mites and for some fungal

diseases. It may cause a chemical "burn" on tender foliage, however, if the air temperature is 90°F or higher. It also may result in a sulfur taste if used on fruits or vegetables shortly before harvest.

Insecticidal Soaps. Recent research indicates certain detergents or soaps are effective in reducing populations of certain soft-bodied pests such as aphids, mites, leafhoppers, plant bugs and thrips when used as sprays. Insecticidal soaps, as they are called, kill insects and mites by disrupting cell membranes, causing cells to burst.

These products usually require thorough coverage and multiple applications. Use soaps or detergents with caution, as leaf injury is possible with certain plants.

Nicotine Sulfate. This "natural" insecticide is derived from the tobacco plant and is highly toxic to humans and other warm-blooded animals. It is **not** recommended for home use.

Proper identification is essential for effectively managing garden pests. A chemical that controls beetles may have little or no effect on aphids or other pests.

The following sections will help you identify a pest problem and select an appropriate management approach. *Table 1* describes commonly observed insect damage to garden vegetables and lists the possible insect or group of insects involved.

Also included is information on pest identification, biology and management guidelines.

Example: If you suspect a pest problem on leaf lettuce, look up "Leaf Lettuce" in *Table 1*. What is the damage like?

If it consists of leaf yellowing, aphids or leafhoppers are the most likely cause. Proceed to the descriptions of these two kinds of pests (turn to the *Pest Identification, Biology and Management Guidelines Section*) and decide which is responsible for the damage.

Do the observed pests fit the descriptions? If so, and if the pests are aphids, for example, refer to the companion *Extension Circular, Insecticide Recommendations for Garden Vegetables, EC89-1552*, for materials suggested for control of aphids on leaf lettuce.

If the lettuce will be ready to harvest in eight to 10 days, select a control material with a short waiting period (e.g., pyrethrins RTU).

This section contains illustrations of common garden pests and descriptions of the pests and the damage they do. Consult companion *Extension Circular, Insecticide Recommendations for Garden Vegetables*, EC 89-1552, for a list of recommended insecticide products. This publication is available at your local Nebraska Cooperative Extension Service office.

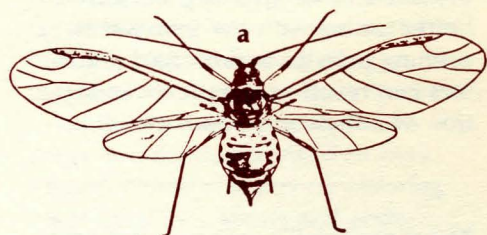


Figure 2. Aphids: a) winged adult; b) wingless adult

Description: Several species of aphids infest vegetable plants in the home garden. Most feed on a wide variety of host plants, including weeds. More common species include the green peach aphid, cabbage and turnip aphids, bean aphid and melon aphid.

Aphids are usually green or yellow in color (cabbage aphids have a gray, waxy covering) and are less than 1/8-inch long. They may be winged or wingless. Reproduction occurs rapidly, and building infestations consist primarily of developing

immature stages.

Aphids feed by withdrawing plant sap through needle-like mouthparts. They often conceal themselves on undersides of leaves. Host plants may appear stunted with yellow discoloration, curled leaves and sticky honeydew secretions present. Some species transmit plant diseases (especially viruses).

Damage can occur throughout the growing season.

Management: Inspect plants regularly and apply insecticides when aphid colonies are small. Withhold application if parasitic wasps, lady beetles, green lacewings or syrphid fly larvae are active.

Another option is to apply an insecticidal soap to conserve beneficial insects. Thorough coverage is essential, and repeated applications may be necessary.

Remove nearby weeds to discourage aphids from using these hosts to build their numbers. Use of a floating row cover may be an effective management strategy for protecting certain plant species.

Pest Identification, Biology and Management Guidelines

Aphids

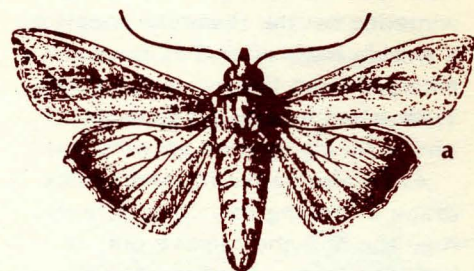


Figure 3. Armyworm: a) adult; b) larva; c) larval head pattern

Description: Armyworms are dark-striped caterpillars that vary in body color from green to tan or brown.

Armyworm

Asparagus Beetles

The head is a pale greenish-brown with a dark "honeycomb" pattern. Fully-grown larvae are about two inches long.

Buff-colored armyworm moths migrate into Nebraska about mid-May and deposit eggs in grassy weeds that border the vegetable garden. Of the three generations we normally have in Nebraska, the last two generally are the most destructive.

When one set of host plants has been defoliated, the worms migrate in large groups or as an "army" to new host plants, which may include

various garden vegetable plants. Feeding mostly occurs at night, with soil, mulches and surface residues serving as daytime hiding places.

Damage is most likely to occur from June-August.

Management: Control grassy weed hosts in or near the garden. Treat when feeding injury is evident and armyworms are found hiding beneath plants. Evening applications often are more effective because of better timing with the armyworm evening activity period. Bird predators can result in significant reduction of armyworm populations.

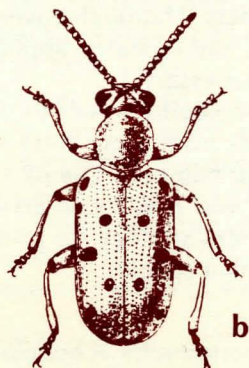
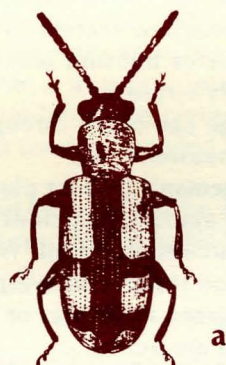


Figure 4. Asparagus Beetles: a) Common Asparagus Beetle; b) Spotted Asparagus Beetle; c) larva

Description: Two kinds of asparagus beetles are present in Nebraska.

The more familiar species, the common asparagus beetle, has metallic blue, orange and creme coloring. Larvae are dull gray with black heads.

The second species, the spotted asparagus beetle, is orange/red with 12 black spots. Larvae are orange-colored.

In the spring, overwintered adults emerge from sheltered areas and attack newly-emerging spears about mid-April. Elongate, oval eggs are laid on growing tips.

Adults of both species and common asparagus beetle larvae chew holes in leaves and stems, while spotted asparagus beetle larvae feed on the berries. Asparagus beetles can cause severe stress for established plants, and can destroy newly-planted beds.

Damage occurs from April to July.

Management: In March, remove dead plant debris and mulches and cultivate the asparagus bed superficially to reduce numbers of overwintering beetles. Examine spears on a weekly basis after they have emerged from the soil in the spring. Treat when beetles are first observed laying eggs on growing tips.

As an alternative to insecticides, drape a floating row cover loosely over the bed and remove only to harvest. Control beetles on ferns after harvest to maintain plant vigor and reduce the potential for infestation next season.

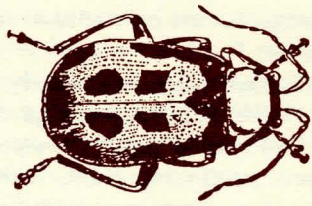


Figure 5. Bean Leaf Beetle

Description: Bean leaf beetles are red/brown, yellow or tan in color, with black markings consisting of four large angular spots in the center of the wing covers, and variable banding along the wing margins. The length of the body is about 1/4-inch.

Adults overwinter in sheltered areas and emerge in April or May. Beetles damage plants by chewing holes in leaves, stems and pods. Young seedlings are particularly susceptible to injury and can be damaged severely by the loss of cotyledons.

When abundant, beetles continu-

ously migrate into the garden from adjacent areas such as alfalfa and soybean fields. Defoliation can occur rapidly.

Bean leaf beetles are elusive day-feeders, falling to the ground or hiding behind leaves when disturbed. Larvae feed on bean roots, but damage usually is insignificant.

With two generations per season, damage from this beetle most likely will occur in May, July and September.

Management: Covering plants with floating row covers until flowering is an effective way of excluding bean leaf beetles. Insecticides also can be applied when holes are first evident on leaves. Repeat the insecticide treatment if damage appears on new growth. Several applications often are necessary when adult numbers are high.

Bean Leaf Beetle

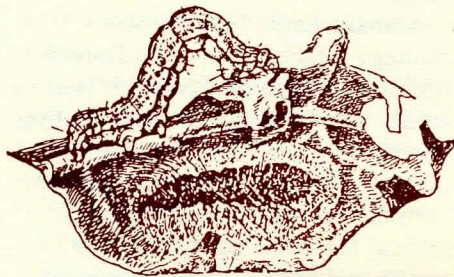


Figure 6. Cabbage Looper larva and pupa in cocoon

Description: Cabbage loopers are caterpillars with light green bodies which taper toward the head. Several white stripes run the length of the body, and movement is accomplished by a "looping" motion.

Cabbage loopers overwinter as pupae within cocoons on host plant debris. Brown, night-flying moths emerge in May and deposit round, pinhead-sized, light green eggs on upper leaf surfaces.

Developing loopers devour leaf

tissue between veins, chewing from the outer edges inward. They often conceal themselves within deeper leaf layers of cabbage heads. In addition to cultivated plants in the cabbage family, cabbage loopers occasionally attack beans, potatoes, spinach, tomato, lettuce, parsley and peas.

There may be two to three generations per season. Damage occurs from June through October.

Management: Remove or destroy crop residues and protect developing plants with floating row covers. Plants can be treated with an insecticide when damage from small worms is first observed, and thereafter, when worms and new damage are observed. Formulations of *Bacillus thuringiensis* are recommended, as they are harmless to people, animals and beneficial insects.

Cabbage Looper

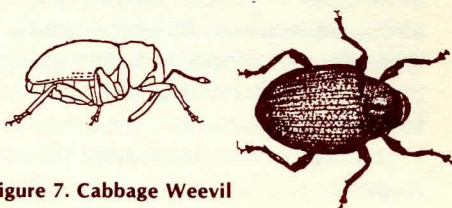


Figure 7. Cabbage Weevil

Description: A few closely-related species of weevils occasionally damage cabbage, radish and other related plants during late spring. Ornamental host plants include alyssum and nasturtium. These

Cabbage Weevils

Carrot Weevil

weevils are approximately 1/8-inch long and dull gray, except for one species that is dark metallic blue. By far the most common of these pests is the cabbage curculio.

Overwintered adults migrate from sheltered areas to wild mustard hosts in the early spring. In June, as these hosts begin to decline, adults move to cultivated cruciferous crops. Adults chew numerous small holes in leaves, stems and buds, while larvae feed within stems. Plants quickly become unsuitable for human consumption, and may be destroyed by the weevils.

Description: Carrot weevils are primarily pests of carrots, but also may attack dill, celery, parsley and parsnips. Weedy hosts include dock, plantain, wild parsnip and carrot.

Adults (weevils) have protruding snouts and are brown to black with a body length of 1/4-inch. They overwinter in the soil beneath surface debris, begin to emerge about mid-April, and soon migrate to nearby host plants. Adults chew holes in lower surfaces of petioles or into plant crowns. They insert eggs, which hatch in a week.

The larvae are white, legless grubs that move down into the soil and tunnel along outer root surfaces, causing unsightly damage and

Damage occurs primarily in June and July.

Management: Destroy weedy plants in the vicinity of the garden. In gardens with a history of weevil problems, protecting plants with floating row covers may be beneficial.

Apply insecticides when weevils and damage are first apparent, and thereafter when weevils and damage reoccur. Also, treat the soil around and beneath the host plant, where weevils hide. Thorough coverage is important.

decay. Tunneling into stems or stalks often causes foliage wilting.

Mature larvae pupate in the surrounding soil and adults emerge in July to begin another generation. Damage occurs from May to late August.

Management: To minimize damage, plant carrots in different locations of the garden each year or rotate carrots annually with another non-host crop. Control weedy host plants in the vicinity of the garden. Timing insecticide applications is critical for adult control. In the spring and early summer, examine plants regularly and treat when adults are first detected.

Colorado Potato Beetle

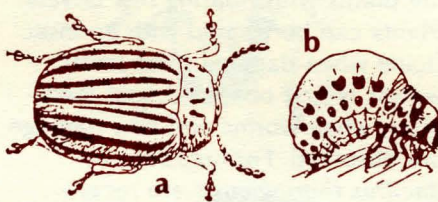


Figure 8. Colorado Potato Beetle: a) adult; b) larva

Description: Originally a pest of native weedy plants such as buffalo-bur, the Colorado potato beetle has become a notorious pest of potato and other related crops, such as tomato, eggplant and pepper.

Damage is characterized by leaf defoliation by adults and larvae. This results in reduced yield, or even

death in cases of heavy infestation.

Adults are oval, tan-colored beetles about 5/8 to 1/2-inch long, with thin black stripes on the wing covers. Larvae have a black head and legs with a swollen, glossy red or orange abdomen.

Adults overwinter in the soil and emerge in late spring. After some feeding, females deposit yellow/orange eggs in clusters on the undersides of leaves. Larvae feed for about three weeks before reaching maturity and dropping to the ground to pupate. A second generation follows.

Damage occurs from June to August.

Management: Colorado potato beetles have an array of natural enemies including birds, predaceous stink bugs, parasitic tachinid flies and others that assist in keeping numbers below damaging levels. Select insecticides and management

strategies that effectively control beetles yet conserve natural enemies. Spray or dust when damage first appears and beetles or larvae are present. Repeat treatment as needed.

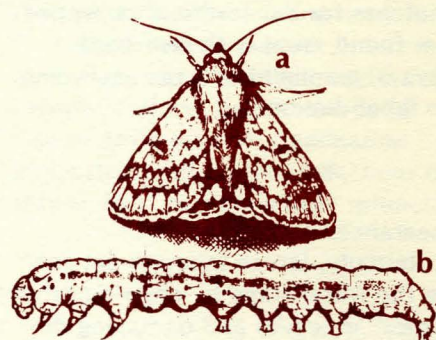


Figure 9. Corn Earworm/Tomato Fruitworm: a) adult; b) larva

Description: This caterpillar is a common and destructive pest, especially on sweet corn (corn earworm) and tomatoes (tomato fruitworm).

It feeds on a wide range of other host plants, including cotton (cotton bollworm), sorghum (sorghum headworm) and soybeans (soybean podworm). The pest has a unique name on each host.

Mature earworms are 1 1/4-inch long and have brown heads with light mottling. The body color pattern is highly variable, but dark stripes usually run the length of the body, alternating with green, yellow, brown or pink bands.

Buff-colored earworm moths begin migrating into Nebraska from the south in June and deposit single

creamy-white eggs on plants. On sweet corn, eggs are deposited on the green silks. Damage occurs when larvae feed in the ear tips. Usually only one earworm develops to maturity in each ear because of cannibalism.

Damage to tomatoes occurs when fruitworms bore holes into the developing fruit. This results in contamination and decay by bacteria and fungi. Damage often occurs to concealed surfaces of the fruit, such as on the inside of a cluster where tomatoes come into contact with each other.

Damage to both sweet corn and tomatoes is most common beginning in mid-July.

Management: Resistant varieties of sweet corn that have tighter husks may reduce corn earworm infestations. Early planted or early maturing sweet corn also is more likely to escape infestation. Examine later plantings of sweet corn every other day for eggs or small worms in green silks. If found, treat silks every two to four days until the silks turn brown. Once fruitworm damage is observed on tomatoes, treat every seven to 10 days. Be sure to observe harvest waiting periods.

Remove and discard damaged tomatoes.

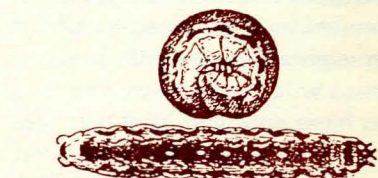


Figure 10. Variegated Cutworm Larva

Description: Several species of cutworms can be pests on a variety of vegetable crops, but the most common are the black and variegated cutworms.

Cutworm problems tend to be

most severe in the spring and early summer, particularly during cool, wet weather conditions. Night-flying moths deposit eggs on grassy weeds, soil, plant debris or young plants. Newly-hatched larvae climb onto plants and feed on foliage at night. They hide under mulches, soil clods or debris during the day.

Mature black cutworms, which are dark brown or black and greasy in appearance, cut plants off at the base. Large numbers of young seed-

Corn Earworm/ Tomato Fruitworm

Cutworms

European Corn Borer

lings or transplants can be destroyed overnight when cutworms are abundant.

Variegated cutworms are gray with an orange stripe on each side of the body and a row of yellow spots along the back. Cutworms pupate in the soil and there may be two to three generations per season, depending on the species.

Management: Place cutworm barriers such as paper collars, tin cans with the bottoms removed, or similarly prepared plastic containers

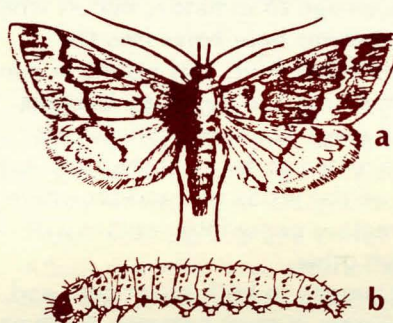


Figure 11. European Corn Borer: a) adult; b) larva

Description: The European corn borer is a common pest of field and sweet corn, and occasionally may damage potatoes, green beans, tomatoes and peppers.

The buff-colored moths deposit egg masses on the undersides of leaves in June, and again in late July or early August. Egg masses are white, with flattened eggs overlapping each other like fish scales. A mature larva is about one inch long. It is gray to tan in color with dark spots, and has a somewhat waxy ap-

pearance. Replace loose mulches with plastic covers and remove nearby weedy host plants.

In new gardens that were formerly in sod or weeds, a preventative soil treatment may be justified. If an infestation is suspected due to the presence of cut plants or ragged leaves, check beneath soil clods or mulches for cutworms. If cutworms are found, treat with insecticide sprays, granules or baits according to label directions.

pearance.

Initially, larvae injure sweet corn in the whorl stage by chewing "shot-holes" in leaves and damaging developing tassels. Later they bore into leaf midribs, stalks and ears, causing leaf and stalk breakage and poorly developed ears. In other vegetables, larvae bore into stems, pods or fruit causing breakage or contamination from invasion by bacteria or fungi.

Management: Examine plants regularly for the presence of egg masses. In smaller plantings, destroy egg masses by hand. In sweet corn, treat when small larvae are present or when shot-hole damage is first observed on leaves emerging from whorls. Once borers tunnel into plants, control is no longer possible.

In other crops, treat if damage is evident on developing pods or fruit. It may be advisable to mow tall grasses around garden perimeters, because this is where moths rest during the day.

Flea Beetles

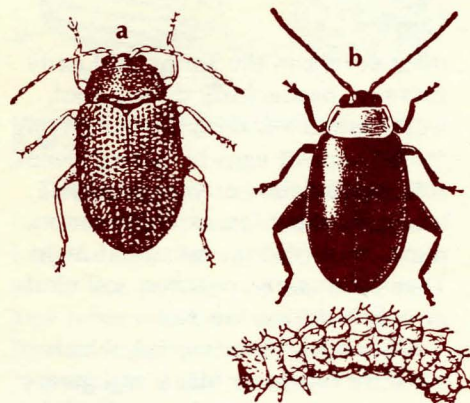


Figure 12. Flea Beetles: a) Potato Flea Beetle; b) Spinach Flea Beetle adult and larva

Description: Several species of flea beetles feed on a variety of garden vegetables, as well as on numerous wild hosts. Most flea beetles have enlarged hind legs that allow them to jump when disturbed. The two most common species that infest gardens in Nebraska are the potato flea beetle and the spinach flea beetle.

The potato flea beetle is a common pest of potatoes and eggplant. These beetles are elongate-oval, black, and about 1/8-inch long.

Overwintered adults feed on weedy hosts in the spring until cultivated plants are available. Eggs are laid in the soil at the bases of plants, and developing larvae feed on roots and tubers.

Adults injure foliage by chewing small holes or pits into the leaf tissue. They can transmit early blight disease during the feeding process.

Spinach flea beetles are 1/4-inch long, dark green to black, and have yellow "collars" behind the head. Larvae are gray, warty appearing grubs that feed on the undersides of leaves. Host plants include spinach,

beets, lambsquarters and pigweed.

Damage consists of irregular holes chewed into leaves by both larvae and adults. Depending on the species, flea beetles can have one to three generations per season.

Management: Destroy nearby weedy host plants and protect plants with floating row covers, where possible. Treat infested plants with an insecticide when damage first is detected and beetles or larvae are present. Watch new growth for damage and treat again if necessary.

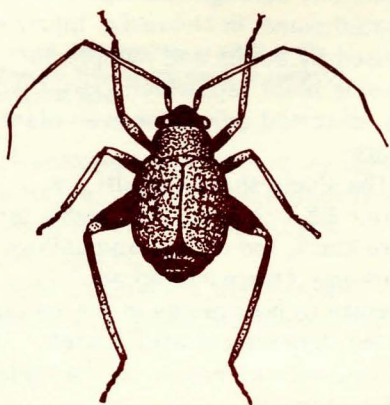


Figure 13. Garden Fleahopper adult

Description: These "true bugs" are black, oval and about 1/8-inch long. They have long antennae and muscular hind legs that aid in hopping and rapid movement.

Overwintered adults emerge from sheltered areas in the spring and attack a wide range of garden, ornamental and weedy plants. Eggs are laid within leaf tissue, and after hatching, green developing nymphs conceal themselves on the under-

sides of leaves. Feeding involves sucking plant juices through needle-like mouthparts.

Damage appears as light-colored flecks on leaf surfaces that gradually merge to produce extensive discoloration. Heavily infested foliage dies and drops from the plant.

Garden fleahoppers prefer cool, moist weather. In the summer they usually confine themselves to shady sites or plants with dense foliage. There are three to five generations per season.

Management: Remove nearby weedy host plants to help reduce localized garden fleahopper numbers. Where possible, prevent the accumulation of dense foliage, or thin plants to maintain good air circulation. Row covers may be an effective management strategy for certain plant species.

Apply insecticidal treatments when damage is first evident in the spring. Direct spray and dusts to undersides of leaves. Repeat treatment as needed according to label directions.

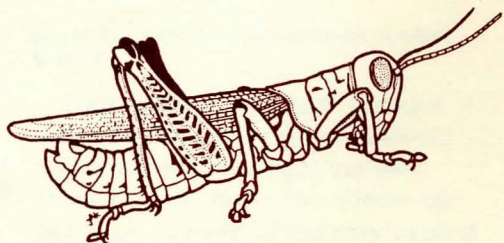


Figure 14. Grasshopper

Description: These chewing insects have leathery forewings and enlarged hind legs adapted for jumping. They may reach a length of three inches, but most are 1 1/2 inches long or less.

Grasshoppers feed on various grassy and broadleaf weeds and move into vegetable gardens when

Garden Fleahopper

Grasshoppers

Harlequin Bug

numbers are high or when preferred hosts begin to die down or have been consumed. Eggs are laid in the soil the previous autumn and usually are destroyed by tillage.

Non-tilled, weedy areas surrounding the garden often serve as a reservoir for each season's infestation. Young hopper nymphs look like adults, except for the absence of wings. Both adults and nymphs damage plants by chewing ragged holes in leaves.

When infestations are heavy, grasshoppers can strip entire plants. The worst damage usually occurs from mid-July through September.

Management: To minimize damage from grasshoppers, control excessive weedy growth around gardens. Treat border areas with an insecticide when hoppers are small and number six or more per square yard. Insecticidal controls should be applied before hoppers are half grown to be effective.

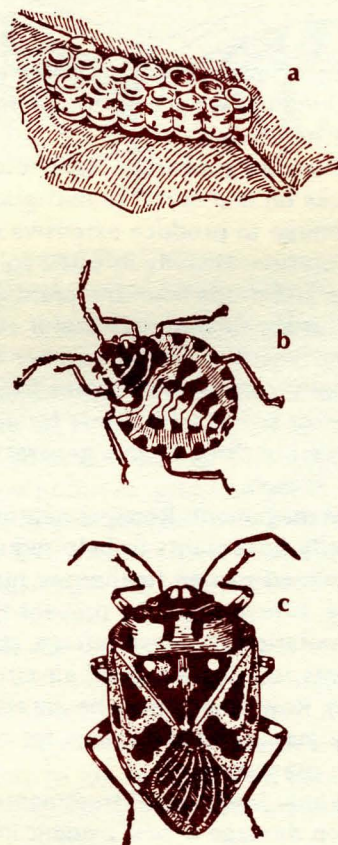


Figure 15. Harlequin Bug: a) eggs; b) nymph; c) adult

Description: Harlequin bugs are more abundant in the South but occasionally damage cabbage and related plants in Nebraska. Injury is caused by adults and nymphs removing plant sap, which causes wilting, distorted growth or even plant death.

The shield-shaped adults are about 3/8-inch long, with highly ornate black, red-orange and yellow markings. Overwintered adults migrate to host plants in the spring where they lay colorful, barrel-shaped eggs in masses on the undersides of leaves.

Nymphs are colorful, oval and flattened in form. They have a preference for feeding in groups. Damage can occur from June through September, with two generations possible during the season.

Management: Hand-pick and destroy adults or egg masses as they are discovered. Treat infestations with insecticidal sprays or dusts. Eliminate wild mustard hosts in the vicinity of the garden to reduce numbers of invading Harlequin bugs.

Hornworms

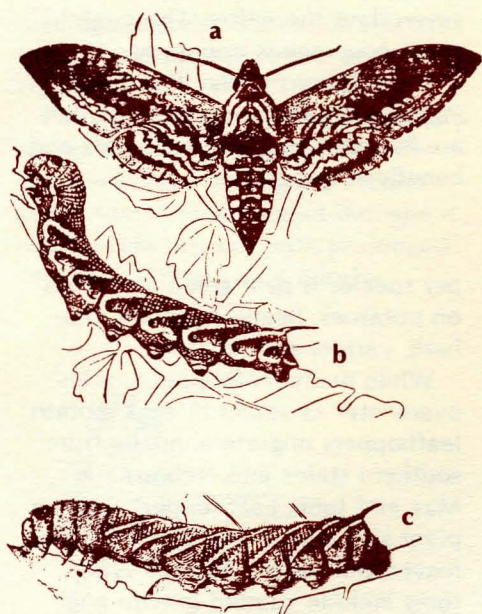


Figure 16. Hornworms: a) adult moth; b) Tomato Hornworm larva; c) Tobacco Hornworm larva

Description: Two species of hornworms (i.e., tomato and tobacco) occasionally feed on tomato and potato leaves.

Both caterpillars are smooth-skinned and green, but tomato horn-

worms have conspicuous white chevron markings on the sides of the body, and a black sensory horn. Tobacco hornworms are characterized by diagonal markings and a yellow sensory horn.

Mature larvae of both species can reach four inches in length. Hornworms overwinter as pupae in the soil with moths emerging in late spring to mate and lay eggs.

Adults are large, gray-brown moths that hover like hummingbirds as they feed on flower nectar at dusk. Green, spherical eggs are laid singly on plants. Large portions or entire plants can be stripped of foliage by developing larvae.

There is one or occasionally two generations per season. Damage is most likely to occur from June through September.

Management: Remove larvae by hand and dispose of them. Encourage natural control by allowing parasitized hornworms (those with small, white cocoons attached to their backs) to remain. Insecticides seldom are needed to control hornworms.

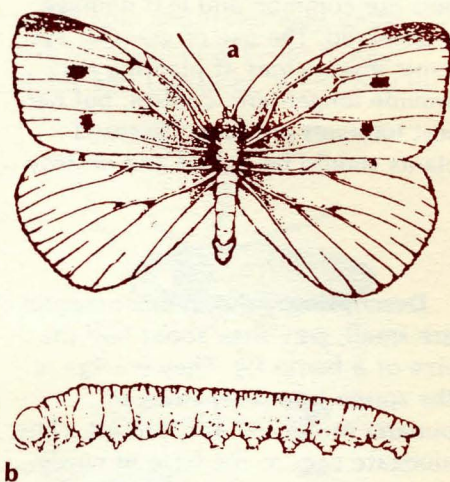


Figure 17. Imported Cabbageworm: a) adult; b) larva

Description: Imported cabbageworm larvae have a green, velvety appearance with a light yellow stripe running down the middle of the back. Mature larvae may exceed 1 1/4 inches in length.

Cabbageworms have a preference for cabbage, broccoli and cauliflower, but readily feed on many other crucifers, including a number of wild hosts. Injury is caused by holes chewed in leaves. Damage to cabbage and broccoli heads can be severe, and edible leafy plants rendered unfit for human consumption.

Cabbageworms often conceal themselves on the undersides of leaves along the midvein, or within leaf whorls. The presence of fresh damage and wet, dark green excrement usually reveal their location.

Cabbageworms overwinter as pupae attached to host plant debris and emerge in the spring as the familiar white cabbage butterflies. Adults deposit single yellow eggs on host plants.

Damage to cultivated plants occurs from May through October, and there may be up to four or five

Imported Cabbageworm

Leafhoppers

generations each season.

Management: Remove or destroy crop residues and protect developing plants with floating row covers. Apply insecticides when small worms first appear, and every five to

seven days thereafter. Thorough spray coverage is important.

Formulations of *Bacillus thuringiensis* are recommended, as they are harmless to people, animals and beneficial insects.

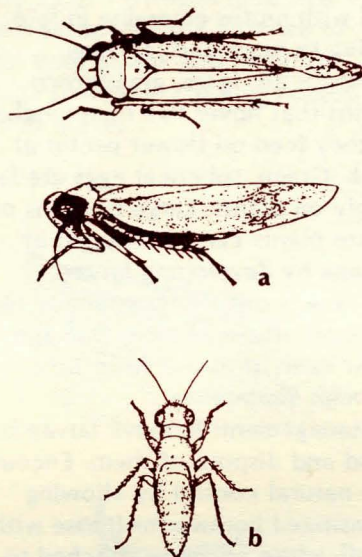


Figure 18. Potato Leafhopper: a) adult; b) nymph

Description: Leafhopper adults are wedge-shaped and vary in color from green to brown. They are typically 1/8 to 3/8 inches in length. Immature stages are elongate, soft-bodied and move rapidly over plant surfaces. Several species feed on vegetables, the most notable being the potato leafhopper. This leafhop-

per species is pale green and feeds on potatoes, beans, eggplant, rhubarb, carrots and lettuce.

While many leafhopper species overwinter as adults or eggs, potato leafhoppers migrate annually from southern states into Nebraska in May and June. Leafhoppers feed on plant sap, which is withdrawn from leaves and stems. Damage symptoms include stunted growth and curling or crinkling of leaves.

A characteristic symptom is "hopper-burn," which is a gradual yellowing of leaves and eventual leaf drop caused by toxins injected into the plant by the leafhopper during the feeding process. Some species transmit microorganisms that cause plant diseases, such as aster yellows of carrots. There are several generations of leafhoppers each season.

Management: Treat when leafhoppers are common and leaf damage is observed. The use of granular systemic insecticides at planting may provide longer-term control, but harvest intervals are long. Diseased plants should be pulled and destroy.

Onion Maggot

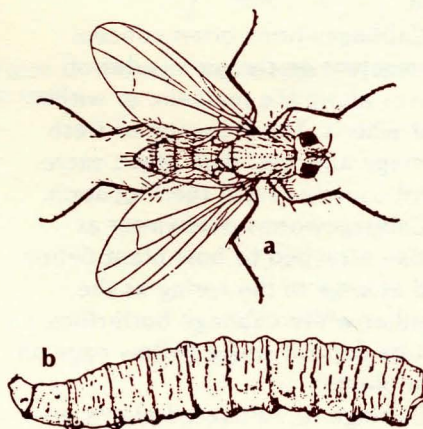


Figure 19. Onion Maggot: a) adult fly; b) maggot

Description: Adult onion maggots are small, gray flies about half the size of a house fly. They emerge in the spring from overwintered puparia in the soil and deposit white elongate eggs at the base of newly-set onion plants. Young cream-colored maggots bore into bulbs, causing physical damage and spreading a bacterial soft rot disease-causing organism.

Portions of densely-planted rows of young plants can be destroyed as maggots move from plant to plant. Bulbs of larger plants can be completely hollowed-out by several

feeding maggots. Above the soil surface, plants appear yellow and lose vigor.

Fully-grown larvae enter the soil to pupate, and emerge as adults a few weeks later to begin a second generation. Onion maggot damage is most severe in years with prolonged cool, wet springs, or in poorly-

drained soils.

Damage is most likely to occur from April to July.

Management: Plant onions into well-drained soils or specially-prepared beds. Treat the furrow with a soil insecticide before setting bulbs or transplants, or before sowing seed.

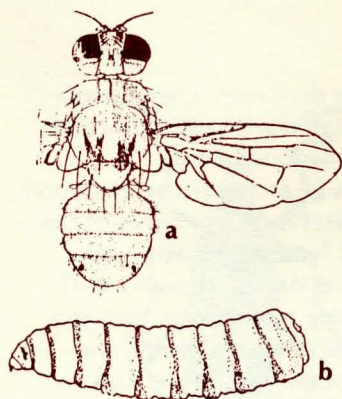


Figure 20. Pepper maggot: a) adult; b) maggot

Description: The adult pepper maggot is a small fly about 1/4-inch long, with a yellow body and clear, brown-banded wings. Flies emerge from overwintered puparia in the soil in July and insert eggs under the skin of developing peppers, egg-plants and tomatoes. Wild hosts in-

clude horse nettle and ground cherry.

The first (and often overlooked) sign of infestation is dimples that develop where eggs were inserted. Fruit development may be two-thirds complete when maggots hatch from the eggs and begin tunneling throughout the interior. At harvest time the infested fruit may appear sound on the outside, but will have blackened and spoiled areas in the interior. Close examination should reveal the presence of cream-colored maggots. There is only one generation each season.

Management: Examine plants regularly and apply insecticides when adults are first detected. Repeat treatment as needed, but be careful to observe pre-harvest intervals. Remove dimpled (infested) fruit from the plants to stimulate further fruit production.

Pepper Maggot

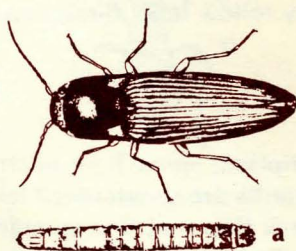


Figure 21. a) Wireworm adult and larva; b) Seedcorn maggot adult and larva

Description: Damage to newly-planted seeds of corn, beans and peas, as well as seed pieces of

potato, by soil-dwelling, seed-feeding insects, often is intensified by prolonged periods of cool, moist weather or other conditions that delay germination. Major seed-feeding insects include wireworms, seedcorn maggots and seedcorn beetles.

Wireworms are the larval (immature) stages of click beetles. They have tan to brown, smooth, segmented, worm-like bodies that may exceed an inch in length. Not only do these insects damage seeds, they also may chew holes into developing underground stems of young seedlings, causing them to wilt and die.

Seedcorn maggots are the larval stages of a small, gray fly. Eggs are

Seed-Feeding Insects

Slugs and Snails

laid in cool, moist soil having an abundance of decaying plant material. Developing maggots feed in this high organic matter soil and eventually move to seeds or roots.

The seedcorn beetle complex consists of two species of small ground beetles. These beetles typically feed on seeds near the soil surface that have been softened by moisture.

Management: Once the seed is planted, little can be done to con-

trol seed-feeding insects. Probably the most effective way of reducing injury from these pests is through the use of an approved insecticide applied to the seed prior to planting. In-furrow insecticide treatment applied at planting also is reasonably effective.

The use of high quality seed to ensure rapid and uniform germination is always a wise practice.

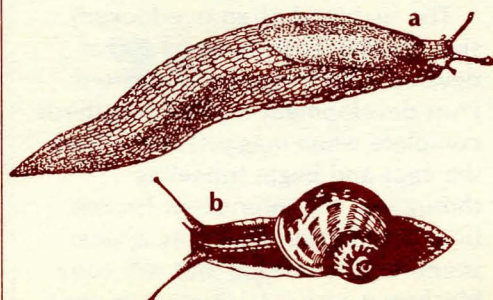


Figure 22. a) Slug; b) Snail

Description: Slugs and snails thrive in moist conditions and are common in gardens that have been overwatered or are heavily mulched. Heavy leaf litter and neglected compost piles often serve as harbors for these pests. Prolonged rainy periods may entice them into the open and increase their activity.

Slugs lack shells and vary in length from one to three inches. Their color varies from tan to dark brown, depending on the species.

Snails have shells that may reach

an inch in diameter. They usually are associated with creek bottomlands and wooded areas.

Both slugs and snails tend to conceal themselves on or beneath the plant and feed during the cooler parts of the day or at night. With their rasping mouthparts they produce holes in leaves, stems and fruit. Slugs and snails are slow-moving and leave silvery slime trails as they move over plant surfaces.

Management: Reduce watering frequency or change methods of watering so conditions are less suitable for slugs and snails. Remove excessive litter or mulch that may have accumulated.

Molluscicides containing metaldehyde are available in liquid, granular or bait form for use in vegetable gardens. Use of baits and granules is not advised when small children or pets are present. Always read and carefully follow label directions.

Spinach/Beet Leafminer

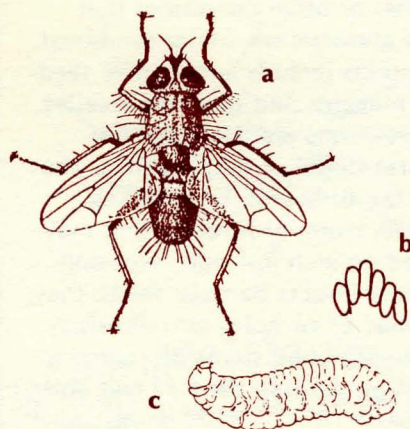


Figure 23. Spinach Leafminer: a) adult; b) egg mass; c) maggot

Description: Spinach (or beet) leafminer adults are quarter-inch long, gray-black flies that first emerge from overwintered puparia in the soil in April. Among the plants attractive for egg-laying are spinach, beets, chard and weeds such as chickweed, lambsquarters and nightshade.

White, elongate eggs are deposited in small clusters on the undersides of leaves. Upon hatching the tiny maggots begin to tunnel between the upper and lower surfaces of the leaf.

As maggots continue to feed and grow, the mines increase in size, rendering leaves unfit for human consumption. Beet roots may suffer delayed development and may be reduced in size as a result of this feeding.

Mature maggots drop to the soil to pupate. There may be three to four generations each season.

Damage occurs from May through October.

Management: Destroy weedy host plants around the garden and prevent infestation up to harvest with floating row covers. Regularly examine leaves and remove eggs by hand or treat with an insecticide when egg clusters begin to appear on the undersides of leaves.

Observe pre-harvest intervals when insecticides are used.

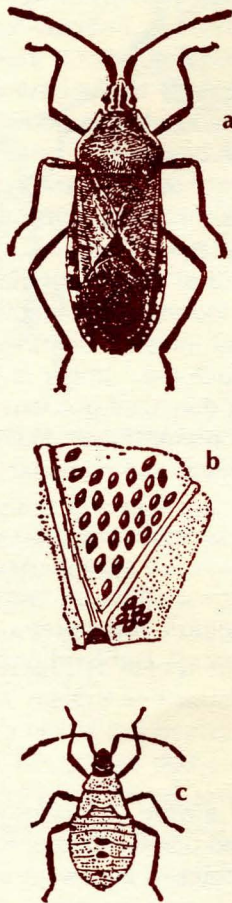


Figure 24. Squash Bug: a) adult; b) eggs; c) nymph

Description: Squash bugs feed exclusively on cucurbits, and have a preference for squash (winter and summer), pumpkin, cucumber and melon, in that order. Adults are predominately gray, 5/8-inch long and somewhat flattened. They over-

winter in surface debris and in other sheltered areas near former plant hosts. Adults emerge and migrate to new hosts in late June or July.

Bronze-colored eggs are deposited in clusters on the undersides of leaves within the "V"s formed by leaf veins. Nymphs are light gray and feed along with adults in clusters, removing sap from stems, leaves and fruit. While feeding, squash bugs inject a toxin into the plant. This causes affected areas to wilt and die.

One generation occurs each year, but because of an extended egg-laying period, adults and nymphs can be present until frost. Damage is most severe from late July through September.

Management: Encourage vigorous growth of plants through proper watering and fertilization. Where squash bugs are abundant, plant more resistant squash varieties such as acorn and butternut. Avoid the Hubbard variety which is relatively susceptible to this insect.

Hand-pick adult bugs and nymphs and destroy egg masses to reduce infestation levels. Place small boards under plants to attract adults as they seek hiding places, and follow up by treating congregated adults with an insecticide.

Avoid insecticidal treatments when honeybees are active in pollinating flowers (mid-morning to early evening).

Squash Bug

Squash Vine Borer

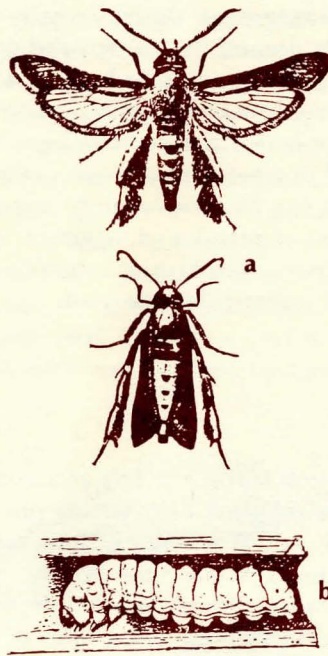


Figure 25. Squash Vine Borer: a) adults; b) larva

Description: Squash vine borers can be destructive to most pumpkins and squashes, but some varieties are more susceptible than others. Larvae have cream-colored, smooth bodies and brown heads. A fully-grown larva is about an inch long. This pest overwinters as a pupa in the soil.

Wasp-like, black and red, clear-winged moths emerge from late May through July and deposit brick-red eggs at the base of plants just above

the soil line. Larvae hatch from the eggs in about a week and immediately bore into stems. Larval tunneling disrupts water and nutrient flow and causes stems to split and decay. Sawdust-like excrement and bacterial ooze often is pushed from holes in infested stems. Infested plants fail to produce fruit, wilt, and eventually may die.

Serious damage mainly occurs from July through September. There is one generation each season.

Management: Control of the squash vine borer is difficult. To reduce damage, insecticides (preferably dust formulations) must be applied regularly to the base of plants during the egg-laying period. Thorough coverage is essential for satisfactory results. Late or staggered planting may help some plants escape infestation.

A liquid or paste formulation of *Bacillus thuringiensis* injected into tunnels of infested stems should help reduce the number of borers. Covering damaged portions of vines with soil promotes secondary root development and minimizes borer damage.

When possible, plant borer-resistant varieties of squash. Acorn and butternut squashes are more resistant to squash vine borer injury than are buttercup, Hubbard and summer squashes.

Stalk Borer

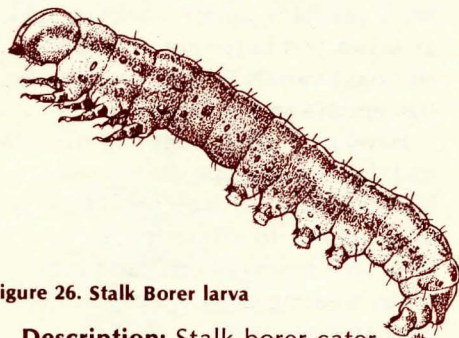


Figure 26. Stalk Borer larva

Description: Stalk borer caterpillars generally can be recognized by their purple-striped bodies, and darkened abdominal segments in the central portion of the body. The mature larva, however, which may reach 1 1/4 inches in length, may be solid white or pale purple.

Stalk borers tunnel within the

stems of a wide variety of wild and cultivated plants. Among the vegetables attacked are sweet corn, tomato, pepper, potato and rhubarb. A preferred weed host is giant ragweed.

The only early indication of stalk borer infestation is a small entrance hole near the base of the stem. Later on, plants begin to wilt or topple over.

Stalk borers overwinter as eggs on weedy plants. As developing larvae outgrow these wild hosts, they migrate at night to nearby garden plants, where they complete development. Most damage occurs in June and July. Pupation takes place

in the soil, with brown, night-flying moths emerging to mate and lay eggs in late summer. There is a single generation each year.

Management: Once stalk borers

enter the plant, control is no longer possible. Removing nearby weedy host plants may help reduce stalk borer infestations.

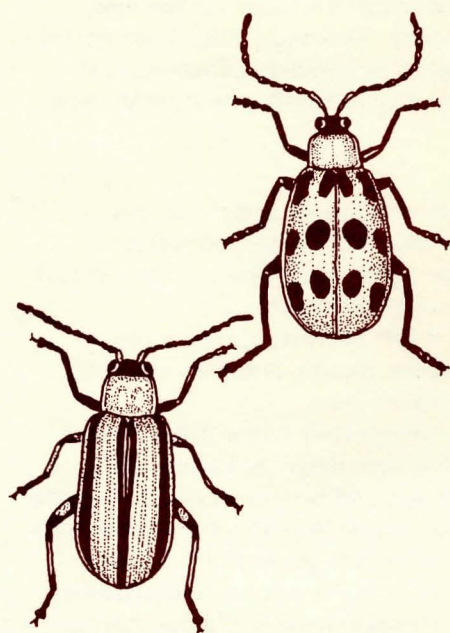


Figure 27. Spotted and Striped Cucumber Beetles

Description: Although striped and spotted cucumber beetles are common from late spring through fall, they are most abundant and destructive from July through early August. While both species feed primarily on cucumbers, melons and squashes, the spotted cucumber beetle has a far greater host range that also includes corn, green beans, potatoes, tomatoes and cabbage. Both beetles

are yellow and black in color and roughly 1/4-inch long.

The striped species has three black stripes on the wing covers, whereas the spotted species has 12 black spots. Both species overwinter as adults.

In the spring, eggs are deposited in the soil and larvae develop by feeding on the roots of host plants. Adults injure plants by chewing holes in leaves, stems, blossoms and fruit. Tender seedlings can be destroyed completely. More importantly, both species transmit a bacterial wilt disease of cucurbits.

To prevent this destructive disease, infected beetles must be controlled before beginning to feed. For additional information on bacterial wilts of cucurbits, refer to *NebGuide G74-108, Wilts of Cucurbits*.

Management: Dust or spray plants regularly once beetles are detected. To avoid harm to pollinators such as honeybees, do not treat plants that are in bloom. In the evening when honey bees are not active, flowering plants can be treated with a non-persistent insecticide such as rotenone or pyrethrins. Removing and destroying wilted vines helps reduce spread of the disease to healthy plants.

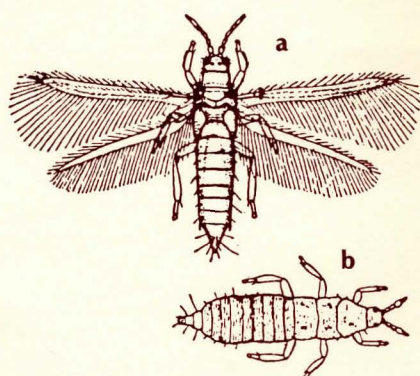


Figure 28. Thrips: a) adult; b) larva

Description: Several kinds of thrips damage a variety of plants in the home garden. Onions, cabbages, tomatoes, green beans and leafy vegetables commonly are attacked.

Adult thrips are tiny, usually tan to black, with elongate bodies having four feathery wings folded over the back. Nymphs resemble adults but are wingless and cream-colored.

Nymphs and adults damage plants with rasping-sucking mouthparts, producing light colored scratches or

Striped/Spotted Cucumber Beetles

Thrips

Twospotted Spider Mite

streaks on leaves and stems. Small, black fecal spots usually are associated with thrips damage.

Thrips often hide in leaf sheaths or axils and can be difficult to detect. Heavily damaged plants lack vigor, and flowers may fail to set fruit.

On onions, thrips cause leaves to curl or twist and severely may retard growth. Cabbage leaves develop brown corky ridges and become dis-

colored. Several generations of thrips occur each season, with damage most likely from June through September.

Management: Apply an insecticide when thrips and damage first appear. Retreatment may be necessary if damage develops on the new growth. Thorough insecticide coverage is essential to penetrate leaf sheaths and axils where thrips hide.

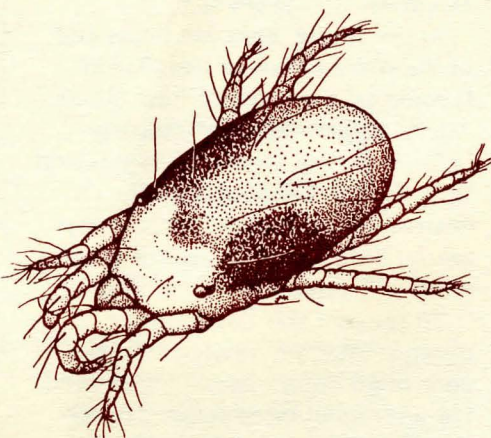


Figure 28. Twospotted Spider Mite adult female

Description: Twospotted spider mites are tiny and appear as pale greenish or tan "spots" on the undersides of leaves. They occur in colonies within fine webbing and feed by withdrawing fluids from plant cells.

Initially, spider mite damage appears as light colored stippling on infested leaves. As feeding continues, leaves turn brown, curl, and may fall off. Reproduction of spider

mites increases under hot, dry weather conditions, so serious damage is most likely from mid-July through September.

If left untreated, plants can decline rapidly and may cease to produce fruit.

Twospotted spider mites have a wide host range including both grasses and broadleaf plants. Among the vegetable plants most frequently infested are green beans, sweet corn, tomato, pepper and squashes.

Management: Avoid purchasing bedding plants that already are infested with mites. Syringe plants regularly with water using a garden hose to disrupt mite colonies and reduce moisture stress to the plants. Anticipate and treat early infestations while they are still small. Thorough coverage is essential with insecticide or miticide applications. Repeat treatment after 10 to 14 days as necessary to prevent serious damage.

In some cases, infested plants or portions of plants may be removed before other plants become infested.