CHAPTER 5

INSECT MANAGEMENT

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Understand how insects grow and develop.
- Understand the difference between simple and complete metamorphosis.
- Be able to identify the major pests of asparagus, carrots, celery, cucurbits, cole crops, onions, potatoes, snap beans, sweet corn, and tomatoes.
- Be able to describe the life cycles and habitats of the major vegetable insect pests.

Insect damage reduces crop yield, quality, or contaminates the final product. Insects can also transmit disease. To effectively control insect pests, you need to understand how insects grow and develop.

GROWTH AND DEVELOPMENT

Growth

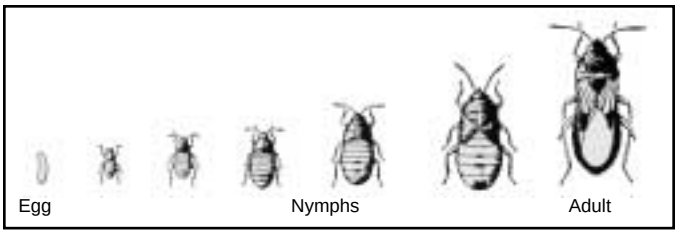
An insect's body is confined in a protective **exoskeleton**. This hard outer covering does not grow continuously. A new, soft exoskeleton is formed under the old one, and the old exoskeleton is shed in a process called molting. The new skeleton is larger and allows the insect to grow a little more. The new exoskeleton is white at first, but it hardens and darkens in a few hours. After the molting process, which usually takes place in hiding, the insect resumes its normal activities.

Development

Insects are divided into groups according to the way they change during their development. The technical term for this change is **metamorphosis**, which means "change in form." Pests of vegetables undergo either simple or complete metamorphosis.

Group 1. Simple Metamorphosis

Insects developing by simple metamorphosis hatch from an egg and resemble the adult insects except that the immatures, or **nymphs**, do not have wings. Nymphs periodically molt, growing larger. After the final molt, nymphs become adults and generally have wings. Many pests of vegetables, such as aster leafhopper, aphids, and tarnished plant bug, develop by simple metamorphosis. Nymphs and adults are often found together in the crop and usually eat the same food.



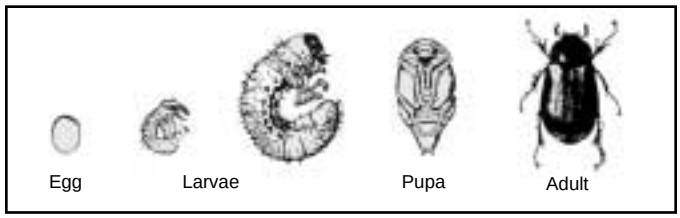
A plant bug is an example of an insect with simple metamorphosis.

Group 2. Complete Metamorphosis

Insects that develop by complete metamorphosis make a radical change in appearance from immature to adult. This group includes beetles, moths, butterflies, flies, bees, and wasps.

In complete metamorphosis, newly hatched insects are called **larvae**. Grubs, maggots, and caterpillars are types of larvae. The job of larvae is to eat and grow; they usually molt four to six times, and then they change into **pupae**. A pupa is an inactive stage of insect development. During pupation, the insect's body rearranges itself, resulting in a complete change in form from the immature to an adult insect. Insects undergoing complete metamorphosis have very different larval and adult

stages. Larvae and adults are often so different that they do not eat the same food and need different habitats.



Development with complete metamorphosis (example: beetle).

CONSIDERATIONS FOR PEST MANAGEMENT

The developmental stages of insects with complete metamorphosis often support rather than compete with each other. It's as if there are two or three completely different animals with different needs and habits, instead of a single species. The larvae feed and live in one habitat and sometimes leave that area to pupate a short distance away. The adult emerges and often eats a different food and lives in another area, returning to the larval feeding site only to lay eggs. One example is the cabbage maggot - the larva is a maggot living and feeding in the roots of cole crops, and the adult is a fly. Species with complete metamorphosis are managed differently according to life stage, where each lives, and what each does. You will want to pay special attention to sections that discuss the life cycle and behavior of each insect pest.

INSECT PESTS OF ASPARAGUS

ASPARAGUS BEETLES

There are two different asparagus beetles in Michigan. The **common asparagus beetle** (*Crioceris asparagi*) is 1/4 inch long, black, red and yellow with a metallic blue head. The adult female lays dark brown, bullet-shaped eggs on asparagus spears. The gray, slug-like larvae and adults feed on tender spear tips until foliage emerges. They will also eat stems and foliage. This feeding weakens plants in a young stand.

Spotted asparagus beetle (*Crioceris duodecimpunctata*) is reddish orange with six black spots on each wing cover. When the asparagus berries appear, the adult female beetles lay eggs. The cream-colored larvae feed only on the berries, not the foliage. Damage to asparagus berries does not cause any economic loss, so the spotted asparagus beetle is not an important pest.

Damage: Asparagus beetles overwinter as adults in crop debris and along field edges. The common asparagus beetle emerges in early spring, slightly before the spotted asparagus beetle. The beetles begin to feed as soon as they emerge and egg laying by the common asparagus beetle starts several days after emergence. Eggs or adults feeding on spears can contaminate the crop and cause consumer rejection. In Michigan, there are typically two to four generations of asparagus beetles per year.

Spotted asparagus beetles cause damage to asparagus berries, not foliage.

Control strategies:

- Many beneficial insects feed on or parasitize asparagus beetles, eggs, and larvae but do not often provide sufficient control in commercial fields.
- Chemical control may be required to reduce contamination and injury to spears or to protect foliage after harvest.

ASPARAGUS MINER (*Ophiomyia simplex*)

The adult asparagus miner is a small, shiny black fly. At the end of May, the female fly lays eggs in the asparagus stalk. Legless larvae tunnel or mine into the stem near the base of the plant. After feeding on the stalks for two to three weeks the larvae pupate near the soil surface. The second generation of adult asparagus miners emerges in mid July. They overwinter as pupae. There are two or three generations per year.

Damage: Feeding by asparagus miner larvae damages asparagus plants. Plants with heavy infestations of miners may become infected with *Fusarium* spp. which causes root rot.

Control strategies:

- Chemical control is not usually necessary to reduce the population.

CUTWORMS

White cutworm feeding on asparagus spear.

Two cutworms commonly feed on asparagus, the **white cutworm** (*Euxoa scandens*) and the **dark-sided cutworm** (*Euxoa messoria*). White cutworms overwinter as larvae, and then emerge in spring to climb the spears and feed on the growing tips from April to May. Dark-sided cutworms overwinter as eggs. Larvae hatch in May and feed on the spears at or near the soil surface. Dark-sided cutworm damage can result in twisted or crooked spears. Cutworm larvae also feed on weeds and volunteer asparagus.

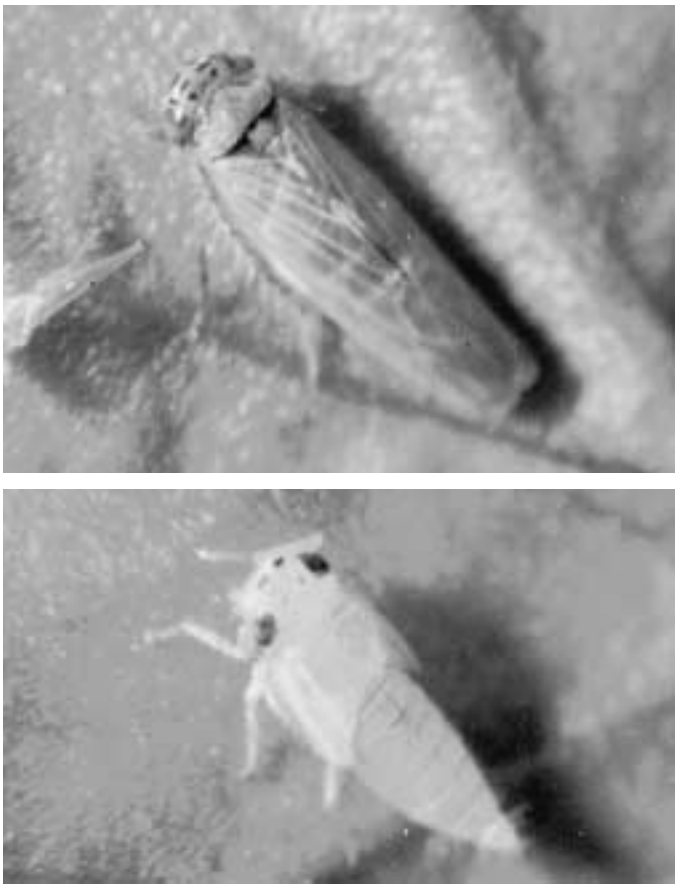
Control strategies:

- Remove weeds and incorporate crop residues to help reduce the cutworm population.
- Cutworm infestations are limited and sporadic. Searching the soil around the plants in the fall and watching for damage during harvest will identify areas needing treatment. Granular insecticide applications in the fall can help reduce the overwintering population of white cutworms.

INSECT PESTS OF CARROTS

ASTER LEAFHOPPER (*Macrosteles quadrilineatus*)

Aster leafhoppers are 1/8-inch-long, yellowish green, wedge-shaped insects with sucking mouthparts. Leafhopper nymphs resemble adults without fully developed wings (simple metamorphosis). In Michigan, aster leafhoppers overwinter as eggs in grasses and small grains and also migrate into Michigan from the southern United States on storm fronts. Aster leafhoppers have many host plants, both weeds (Queen Anne's lace, pineapple weed, and horse weed) and crops (carrots, celery, and alfalfa). In Michigan, there are up to five generations a summer.



Aster leafhopper adults (top) and nymphs (bottom) are pests of carrots and celery.

Damage: Aster leafhoppers transmit the mycoplasma-like organism that causes the disease **aster yellows**. (For more information on aster yellows, see Chapter 7 Disease Management.) Early symptoms of aster yellows disease are yellowing of younger leaves, progressing to red or purple, twisted petioles, and dense shoot growth. Carrots affected with aster yellows are dwarfed, abnormally shaped, covered with hairy growth of secondary roots, and bitter tasting. Aster yellows may also kill plants and reduce carrot size, leading to yield losses.

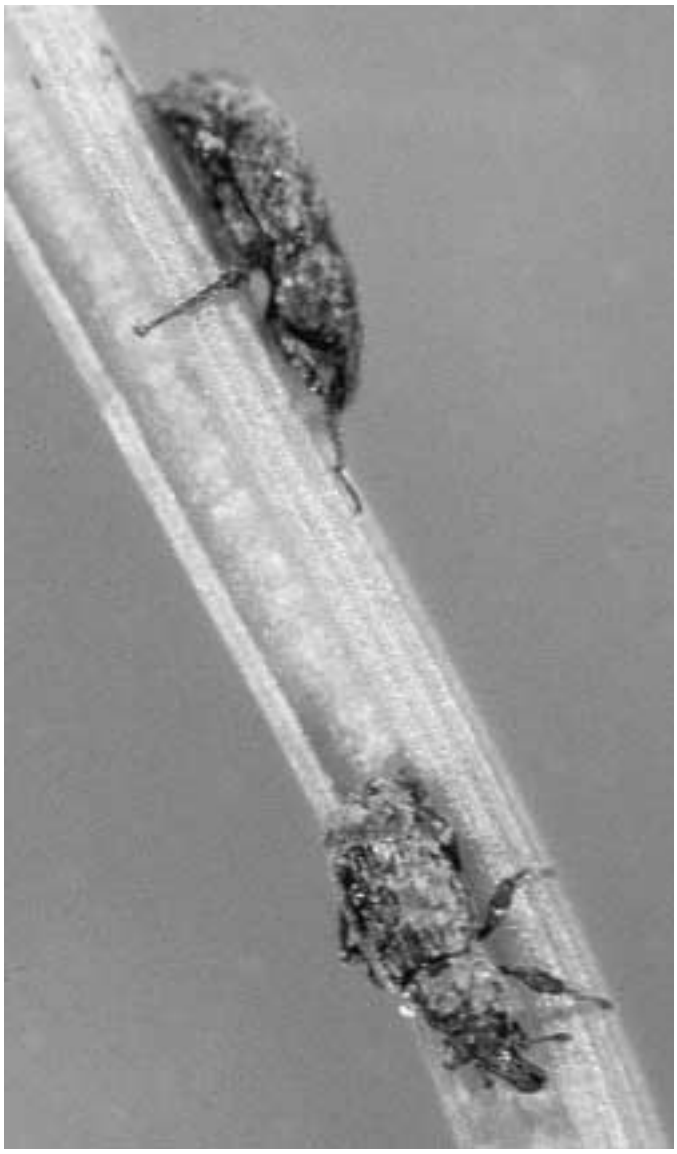
Control strategies:

- Use a sweep net and scout fields regularly, one to two times per week. The action threshold commonly used is 20 aster leafhoppers per 100 sweeps.

CARROT WEEVIL (*Listronotus oregonensis*)

The adult carrot weevil is a snout beetle about 1/4 inch long. Adult weevils overwinter in the soil, emerging in April to May. Female weevils lay eggs in leaf petioles. When larvae hatch, they tunnel into the petiole, then

down into the crown and eventually into the carrot, and feed for two to four weeks. Larvae pupate in the soil, and adults begin to emerge in mid-June. Alternate hosts include celery, parsley, Queen Anne's lace, and some broadleaf weeds.



Adult carrot weevils do not fly.

Damage: Adult carrot weevils do not cause serious damage to carrots. They feed on foliage, making small holes in leaf petioles. However, carrot weevil larvae feed by tunneling in the upper third of the carrot, making the carrot unmarketable for either fresh or processing. Carrot weevil tunnels also create a route of entry for secondary infections by plant pathogens.

Control strategies:

- Practice crop rotation with non-host crops, such as onions or potatoes. This provides control because adult carrot weevils do not fly.
- Control alternate weed hosts (e.g., Queen Anne's lace, plantain).
- Monitor carrot weevil populations with traps baited with carrot. If pesticide applications are made, they can be targeted toward newly hatched larvae with a systemic insecticide or toward molts using a standard insecticide in the spring or early summer when the adults are active. See Extension bulletin E-890, Detection and Control of Carrot Weevil, for detailed information on trapping.

INSECT PESTS OF CELERY

Aster leafhoppers and **carrot weevils** can also attack celery. Please refer to the carrot insect section for information about these pests.

APHIDS

Green Peach Aphid (*Myzus persicae*) and Sunflower Aphid (*Aphis helianthi*)

Aphids are generally characterized by a pear-shaped body with two cornicles or "tailpipes" on the hind end. Adult green peach aphids may vary in color from yellow to light green to pink. Sunflower aphids are green with black cornicles and black legs. There are wingless and winged forms of both aphids. Winged green peach aphids have dark patches on the head, thorax and abdomen.

Adult female aphids reproduce without mating, creating genetically identical offspring. They do not lay eggs but give birth to tiny aphids. Aphids overwinter as eggs on host plants or as adults in greenhouses. They also migrate into Michigan from the southern United States. There are five to ten generations per year.

Damage: Aphids use their sucking mouthparts to drink plant sap and also transmit viruses. Aphid damage can twist and distort new plant growth, and aphids can contaminate the harvested product.

Control strategies:

- Aphids have many natural enemies; lady beetles, lacewings, spiders, parasitic wasps, and fungal diseases help maintain low aphid populations.
- Chemical control for aphids is not usually necessary unless other pesticide applications have eliminated all natural enemies. Aphids can rapidly develop pesticide resistance because aphid offspring are genetically identical.

CELERY LOOPER (*Syngrapha falcifera*) CABBAGE LOOPER (*Trichoplusia ni*)

Celery and cabbage looper larvae are green caterpillars with white stripes on their sides and are up to one inch long. The larvae move like inchworms, bringing their back legs forward and creating a loop with their body. Celery loopers overwinter in Michigan as pupae and emerge as adults in May. Cabbage loopers migrate into Michigan from the southern United States in late June to early July. The adult moths lay white, round eggs about the size of a pinhead. The larvae feed for approxi-

mately two to three weeks, then pupate. Looper pupae are wrapped in a delicate cocoon of white threads that makes them difficult to remove from plant material.

Damage: Looper larvae feed on leaves and petioles of the celery plant, creating small holes. Pupae contaminate product and are of more concern than foliage damage because pupae are difficult to wash off the plant.

Control strategies:

- Regularly scout fields for caterpillars. If marketable petioles are present, insecticide applications may be needed. Remember, pesticides are more effective against small, young loopers, and loopers need to be controlled before they pupate.

Celery loopers (top) overwinter in Michigan but adult cabbage loopers (bottom) migrate into Michigan every year.

TARNISHED PLANT BUG (*Lygus lineolaris*)

Tarnished plant bugs are green (immature) or brown (mature) and shield-shaped. They feed and reproduce on many host crops and weeds. Eggs are usually laid on leaf midribs, and young nymphs generally remain on the new growth on the plant upon which they hatched. Adults are strong fliers and can easily move between fields, from wild habitats, or from other crops into celery.

Adult tarnished plant bug (left) and nymph (right).

Tarnished plant bug adults and nymphs have sucking mouthparts and produce toxic saliva, which causes the area around the feeding site to die. Feeding creates brown spots on leaves and petioles, can cause new growth to twist, and creates entry points for plant pathogens.

Control strategies:

- Tarnished plant bugs have many host plants and are therefore difficult to control using cultural control methods.
- Because they are strong fliers, tarnished plant bug adults can move quickly from field to field, making effective pesticide applications difficult. Frequent scouting is critical.

VARIEGATED CUTWORM (*Peridroma saucia*)

The variegated cutworm can cause severe stalk damage in celery. As early as May, the adult gray-brown moths begin to lay eggs on the undersides of celery leaves. The larvae feed primarily on celery leaves and petioles, creating holes in the stalks. As they grow, larvae begin to move down the plant and feed on the inner surface of the petioles. A small unmanaged population of variegated cutworms can cause extensive damage. Variegated cutworm caterpillars can also contaminate the crop at harvest.

Control strategies:

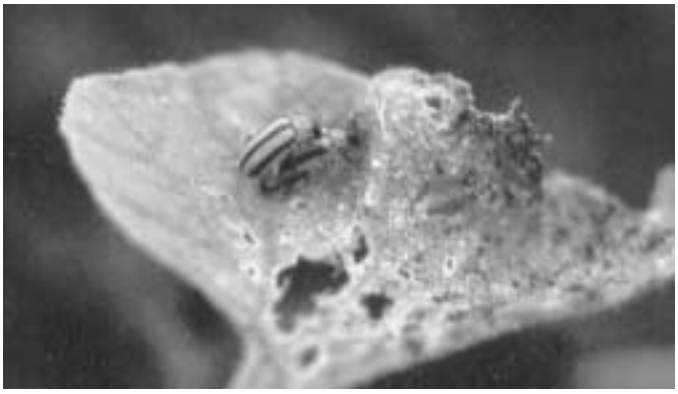
- Scouting the field and visually monitoring for eggs and larvae provide an early warning of caterpillar infestations.
- Monitor for variegated cutworm adults with pheromone lures and traps. Preventive pesticide applications may be necessary once marketable petioles are present (within four weeks of harvest).

INSECT PESTS OF CUCURBITS (CUCUMBER, MELON, PUMPKIN, SQUASH)

APHIDS

Aphids also attack cucurbits. Please refer to the celery insect section for information on the aphids.

CUCUMBER BEETLES



Striped cucumber beetle.

Spotted cucumber beetle.

The **striped cucumber beetle** (*Acalymma vittatum*) and the **spotted cucumber beetle** (*Diabrotica undecimpunctata howardi*) are found on cucurbits in Michigan. The striped cucumber beetle is yellow with black stripes on its wing covers. The spotted cucumber beetle (also called the southern corn rootworm) is yellow or green with black legs, antennae, and head, and 12 black spots on its wing covers. In the spring, striped cucumber beetles emerge from overwintering sites along fencerows and ditch banks to begin feeding on new plants. Spotted cucumber beetles migrate into Michigan each year from the southern United States. Both striped and spotted female beetles lay their eggs in the soil at the base of cucurbit plants. Larvae emerge and feed on the roots and underground portions of the plant stems. Larvae pupate in the soil and when the adults emerge they feed on the foliage, flowers and fruits of cucurbits. The spotted cucumber beetle can feed on more than 200 common plants, including corn, peas, beans and tomatoes, but the striped cucumber beetle feeds only on cucurbits.

Striped cucumber beetles are easily confused with the western corn rootworm. Striped cucumber beetles have faint yellow markings on their legs; the western corn rootworm has solid black legs. Also, striped cucumber beetles have black abdomens; western corn rootworm, yellow. It is important to distinguish between these two beetles because the western corn rootworm does not injure or transmit disease to cucurbits.

Damage: Root feeding by striped cucumber beetle larvae can cause serious damage to undeveloped vines. Adult beetle feeding can completely defoliate young plants or girdle the stems and kill the plants. Cucumber beetle adults also transmit bacterial wilt, a major disease of cucurbits. (See Chapter 7 for more information on bacterial wilt.) In Michigan, the spotted cucumber beetle rarely occurs in high numbers and is not a major pest. Striped cucumber beetles, however, can be a severe problem.

Control strategies:

- Row covers act as a barrier and prevent striped cucumber beetle infestations. However, row covers must be removed for pollination, are not practical for large acreage, and must not have holes that could allow beetles to enter and go unnoticed.
- Trap crops help control early-season beetle infestations. Any cucurbit variety that is extremely attractive to the striped cucumber beetle can be used as a trap crop. Plant the attractive cucurbit along the field border before the primary crop. Striped cucumber beetles attack the most mature cucurbit crop in a given area, so the beetle population will build in the trap crop. This allows limited, effective insecticide applications to prevent beetle movement to the primary crop.
- Cucurbits are very sensitive to pesticides - read the label carefully. Treatment with a systemic insecticide at planting provides excellent control of early-season cucumber beetles without affecting honeybees. When cucurbit crops are in bloom, making foliar insecticide applications in the early morning or late evening reduces insecticide contact with honeybees. Yields can be reduced if the insecticide application harms pollinators.

SQUASH BUG (*Anasa tristis*)

Squash bugs feed on all cucurbits but are more of a problem in squash and pumpkins. Adult squash bugs are dark grayish brown with gold and brown stripes on their abdomens. Females lay eggs in clusters on the undersides of leaves between leaf veins. Newly hatched squash bugs do not have wings (simple metamorphosis) and are pale green to white with reddish brown heads and legs. As they mature, they become grayish white with black legs, and look more like adult squash bugs. Immature squash bugs are commonly found in groups.

Adult squash bug (top) and squash bug eggs (bottom).

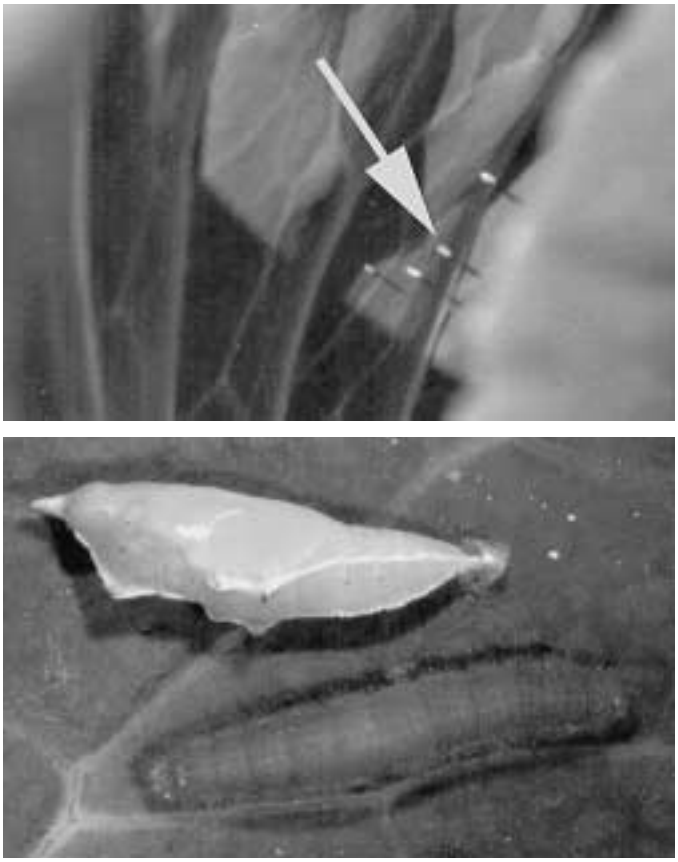
Damage: Nymph and adult squash bugs use their sucking mouthparts to consume plant juices from leaves and fruit. Damaged leaves wilt, turn black and die. In hot, dry weather, large populations of squash bugs can cause plants to wilt. If squash bug problems are detected and controlled early, plants will recover. Late in the season, especially after a killing frost, squash bugs begin to feed on the fruit. Fruit feeding causes the tissue in damaged areas to collapse and makes the product unmarketable.

Control strategies:

- Plant resistant hybrids to reduce young squash bug populations.
- Cultivate immediately after harvest to remove crop debris, and eliminate overwintering sites.
- Natural enemies do not provide adequate control of the pest.
- Insecticide applications targeted at nymphs are more effective than later applications to control adults.

INSECT PESTS OF COLE CROPS (BROCCOLI, CAULIFLOWER, AND CABBAGE)

IMPORTED CABBAGEWORM (*Pieris rapae*)



Imported cabbageworm eggs (top) and larva and pupa (bottom).

The imported cabbageworm is the most common pest of cole crops in Michigan. These white butterflies begin to fly in late April or early May after overwintering as pupae in crop debris. Female butterflies lay bullet-shaped, yellow eggs on the foliage. Imported cabbageworm larvae are velvet green caterpillars with a faint yellow stripe along each side. Larvae usually pupate on the undersides of leaves near the soil surface. The pupae are bright green. The imported cabbageworm completes its development in four to five weeks; in Michigan, there are three generations per year.

Damage: Imported cabbageworm larvae feed on foliage, creating large, irregular holes in leaves. Cabbage plants can tolerate some feeding damage before head formation. Broccoli and cauliflower can withstand some foliar damage. However, as imported cabbageworm larvae grow, they move to the center of the plant, boring into the cabbage head or feeding on the broccoli and cauliflower florets. Imported cabbageworm injury to the growing tip in broccoli can result in head deformation. Feeding damage also increases the plants' susceptibility to diseases. Imported cabbageworms can also contaminate yield and reduce product marketability.

CABBAGE LOOPER (*Trichoplusia ni*)

Cabbage looper larva.

Beginning in late June or early July, cabbage looper adults migrate into Michigan from the southern United States. The adult cabbage looper is a gray and brown moth with a characteristic white/gray figure-eight marking on the wing. The adults are active at night and on cloudy days, laying single white eggs on the undersides of leaves. Cabbage looper larvae move with an inchworm motion - they bring their back legs forward, creating a loop with their bodies. Cabbage loopers pupate on the undersides of leaves, wrapping the brown pupae in cocoons of white threads. There are typically two to three generations per year.

Damage: Cabbage looper larvae feed on foliage, creating large, irregularly shaped holes in the leaves similar to the damaged caused by the imported cabbageworm. Cabbage loopers can contaminate the harvest. They are also pests of celery and tomatoes.

DIAMONDBACK MOTH (*Plutella xylostella*)

Diamondback moth adult and pupa.

Worldwide, the diamondback moth is the major pest of cole crops, but in Michigan, it usually does not cause serious damage. The adults are small, grayish brown moths. The diamondback moth may overwinter in Michigan in crop debris, migrate into Michigan from warmer climates, or be brought in on transplants. Female moths lay very small eggs, which are difficult to see, on leaves and leaf petioles. Diamondback moth larvae are small (1/3 inch long) and yellow-green. When frightened or touched, the larvae squiggle very rapidly and drop off the leaf, hanging from a silk thread (similar to a spider silk). Diamondback moth pupae are small, green, and enclosed in lace-like cocoons. There are multiple generations a year.

Damage: Like imported cabbageworms and cabbage loopers, diamondback moth larvae damage foliage and contaminate the harvest. Larvae feed on the underside of a leaf, leaving a "windowpane" of transparent tissue; where the imported cabbageworm and cabbage looper larvae create irregularly shaped holes in the leaves. Because of their small size, it takes approximately 20 diamondback moth larvae to defoliate as much as one cabbage looper or two imported cabbageworm larvae.

Control strategies for the caterpillar complex:

Cultural:

- Plant broccoli and cauliflower early to help reduce cabbage looper infestation damage.

Biological:

- Several parasitoids attack the imported cabbageworm and cabbage looper.
- Birds and spiders also help control these caterpillars.
- In Michigan, diamondback moth populations are controlled primarily by a very effective parasitoid. This tiny wasp may kill 70 to 80 percent of the diamondback population; however, it is easily killed by most insecticides.

Chemical:

- Regular scouting of cole crops is extremely important. Cabbage looper and diamondback moth adults can be monitored using pheromone (sex attractant) lures and traps. Plants are visually sampled for eggs and larvae of imported cabbageworms and cabbage loopers.
- Biological insecticides such as *Bacillus thuringiensis* are effective against the imported cabbageworm and do not harm biological control agents.
- Cabbage loopers are more difficult to control with insecticides than imported cabbageworms. Insecticide applications are more effective when cabbage looper larvae are small.
- Diamondback moth larvae and adults in some locations have developed resistance to a number of insecticides, including *Bacillus thuringiensis*. *Bacillus thuringiensis* is recommended for diamondback moth control because it does not affect the highly susceptible parasitoid. Insecticides (including *Bacillus thuringiensis*) used to control the imported cabbageworm or cabbage looper may fail to control diamondback moth and actually result in an increased diamondback moth population because the pesticide killed the natural enemies.

CABBAGE MAGGOTS (*Delia radicum*)

Cabbage maggot adults are flies that look very similar to houseflies. Cabbage maggots overwinter as pupae in the soil and emerge in spring. Immediately after emerging, the female flies begin to lay small, white, oval eggs at the bases of cole crop plants in or near the soil. Larvae, otherwise known as maggots for flies, burrow into the soil and attack plant roots. Cabbage maggots have many host plants, including crops (broccoli, cabbage) and weeds (wild mustard). There are three generations per year in Michigan.

Damage: Cabbage maggots feed on young, susceptible transplants and seedlings in early spring, killing or stunting plants. On hot days, damaged plants may wilt. Cabbage maggot damage also creates an entrance for secondary infections such as bacterial soft rot and blackleg (See Chapter 7 – Disease Management). Cabbage maggots can be more of a problem in cool, wet weather.

Control strategies:

- Destroy crop residue to reduce overwintering cabbage maggot pupae.
- Plant cole crops after peak adult flight (mid-to late June) to reduce the number of eggs laid on the crop.
- Several natural enemies, including a parasitic wasp and a nematode, attack cabbage maggots. Ground beetles also eat cabbage maggot eggs. The natural enemy population does not usually provide adequate control in heavily infested fields, however.
- Scouting for adults or eggs of cabbage maggots is difficult. The adults look much like many other common flies, including houseflies. Eggs are very small and difficult to find in the soil. Therefore, preventive soil treatments are commonly used in areas where cabbage maggot has been a problem in the past.

INSECT PESTS OF CORN (SWEET)

CORN FLEA BEETLE (*Chaetocnema pulicaria*)

The adult corn flea beetle is very small—1/16 inch long—shiny, and black, with enlarged hind legs. It jumps like a flea when plants are disturbed. In Michigan, flea beetles overwinter in plant debris along field edges. In the spring, they emerge and feed on grasses and winter wheat if no corn is available. Eggs are deposited in the soil, and the larvae develop in the soil feeding on corn roots.

Damage: Adult corn flea beetles strip off the top layer of cells on a leaf, giving the leaf a scratched appearance. The most severe injury occurs during cold springs, when slow plant growth allows the beetle more time to feed. Corn flea beetles may also transmit a bacterial disease, Stewart's wilt, which can dramatically reduce yields of susceptible hybrids. Disease symptoms may appear at any stage of corn development in certain corn varieties. (Refer to Michigan State University Extension Bulletin E-2034, Chapter 7, Field Crops—Disease, for more information).

Control strategies:

- Plant wilt-resistant sweet corn hybrids.
- Avoid planting susceptible hybrids early in the season.
- Remove crop residue and control weeds to remove corn flea beetle overwintering sites.
- Areas where corn flea beetle and Stewart's wilt have been a problem may require insecticide seed treatment. Foliar insecticides applied to control corn rootworm also offer some control of corn flea beetle. See Chapter 7, diseases of corn, for further information.

EUROPEAN CORN BORER (*Ostrinia nubilalis*)

European corn borer larva (top) and adult (bottom).

The European corn borer is the most serious pest of Michigan sweet corn. European corn borers overwinter as full-grown larvae in corn debris, usually field corn. Beginning in mid-June, the first generation of adult moths emerge and mate in tall grasses. The adult moths are cream to light brown. The female moth lays her eggs, which look like fish scales, on the undersides of corn leaves. The larvae hatch and feed on the leaf, eventually moving into and feeding down in the whorl. As the larvae mature, they enter the stalk to feed and pupate. Second-generation European corn borer adults mate and the females deposit eggs on the leaves in the ear zone of silking corn. The larvae feed on the developing ears, causing kernel damage, or enter the stalk, ear shank, or cob. Depending on the temperature, there are two or three generations of European corn borer per year.

Damage: First-generation European corn borers feed primarily in the whorl, giving the leaves a "shot-hole" appearance. Larger larvae feed within the midrib and burrow into the stalk. Both of these feeding activities disrupt normal movement of plant nutrients and water, potentially reducing yield.

Second-generation corn borers feed on the stalks, tassels, ear shanks, leaves, and kernels. Feeding on the kernels contaminates the crop, and feeding on the ear shank causes the ear to drop. Stalk boring breaks the stalk, making it difficult to harvest and creating entry wounds for stalk-rot fungi.

Control strategies:

A number of factors affect the potential economic loss caused by European corn borer damage. A series of cool evenings (below 65 degrees F) or a heavy rain can reduce the number of eggs laid or the survival of small larvae. In addition, young larvae can dehydrate and blow away on hot, windy days. Thus, conditions present during European corn borer mating, egg laying, and development are critical in determining the population from year to year.

- Destruction of overwintering sites (corn debris) in the fall kills many European corn borer larvae, but, it does not reduce the population enough to provide adequate control the following year.
- Planting early in the season and using resistant hybrids and early-season hybrids are all useful in managing the European corn borer. Tall corn is more attractive to egg-laying females and, therefore, first-generation damage. Likewise, the second generation tends to attack late silking and pollen-shedding corn. Avoid extremely early and late plantings or plant such fields with resistant hybrids. Scouting efforts should be concentrated on fields as they begin to tassel and continue through harvest.

Biological:

A large number of natural enemies attack all life stages of the European corn borer.

- Generalist predators such as lady beetle larvae and adults, lacewing larvae, and minute pirate bugs feed on egg masses and small larvae. Other insects and birds eat large larvae, pupae and adults.
- Though parasitoids have been imported from Europe to control the European corn borer, only a few have been successfully established. The amount of control from these parasitoids varies from year to year and depends on the location and shape of each field.
- Two main pathogens affect European corn borer populations. *Beauvaria bassiana* is a naturally occurring fungus that can kill overwintering larvae. Dead larvae are white and furry-looking. Most epidemics of *B. bassiana* occur during and after periods of rainfall late in the season when temperatures are in the mid-80s F.
- *Nosema pyrausta* is a protozoan-like microbe that reduces European corn borer egg laying, kills some larvae, and increases overwintering mortality. An increase in stress caused by other factors increases the mortality caused by *N. pyrausta.*

Chemical:

Timing is critical to control the European corn borer because once larvae enter the stalk or ear, insecticide applications become less effective. Thus, scouting is crucial. Scout for first-generation corn borers by examining plants for shot-holing. Scout for second-generation corn borers by looking for egg masses on the undersides of leaves, especially in the ear zone. Pheromone traps in grassy field borders help determine presence and abundance of adult European corn borers.

- Insecticide applications during the whorl stage can be effective against first-generation European corn borers. Though they're not commonly used in Michigan sweet corn, research and field corn experience show that granular insecticides control first-generation corn borers more efficiently than liquid insecticides.
- *Bacillus thuringiensis* subspecies *kurstaki* (Berliner), usually known as Bt, is effective against larvae feeding in the whorl, sheath, and collar. Bt kills the corn borer only when it is ingested and is more effective on smaller larvae. Therefore, once the larvae have burrowed into the stalk, Bt is not effective. Though Bt kills the European corn borer and other caterpillars, it is much less toxic to other organisms (including beneficial insects and humans) than most broads-pectrum insecticides.
- A few varieties of transgenic Bt sweet corn are available. Transgenic Bt corn has had the gene that produces the same toxin as the bacterium *Bacillus thuringiensis* inserted into its genetic structure. When a corn borer larva feeds on a transgenic Bt corn plant, the larva ingests the toxin and dies. Like Bt insecticide applications, transgenic Bt corn is much less toxic to beneficial insects and growers than conventional insecticides.

CORN EARWORM *(Helicoverpa zea)*

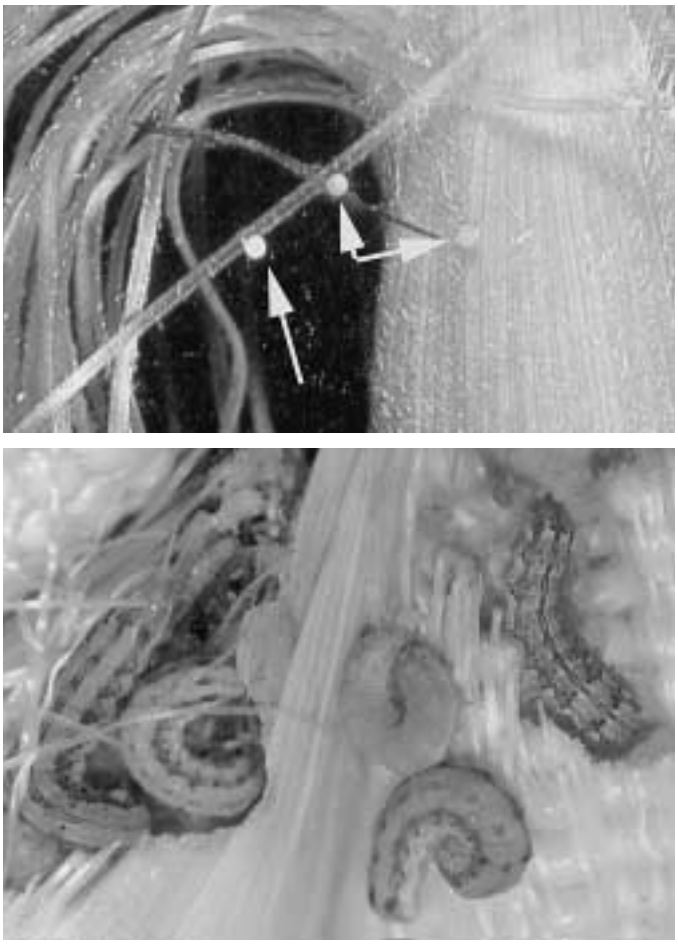
The corn earworm is also known as the tomato fruitworm. Each year, sometime between June and early August, the adult moth migrates into Michigan. Female moths lay small, yellow eggs on corn silks. When the larvae hatch, they begin feeding on the tip of the ear. Corn earworm larvae vary in color from pink, green, and maroon to brown and tan and can be 1¾ inches long. Mature caterpillars drop from the plant and pupate in the soil. There are two to three generations per year in Michigan.

Damage: Corn earworms feed on corn kernels. As they develop, they can eat the entire tip of a corn ear and then move to other parts of the plant or other ears. A fully grown larva will create a large hole in the husk of the ear it has been feeding on when it exits to pupate. Damaged ears are unmarketable, and corn earworm feeding damage creates an entry point for secondary fungal infections.

Control strategies:

Corn earworm adults can be monitored using pheromone lures and traps placed near cornfields. Scout fields to monitor ear feeding. Correct identification is important because corn earworms are more difficult to control than European corn borers.

- Naturally occurring biological control agents such as parasitic wasps and flies, lady beetles, and other predators help control the corn earworm.
- Timing of insecticide treatments and application to the corn silks, where corn earworm eggs are laid, are critical—once corn earworms enter the ear, insecticide applications are not effective.



Corn earworm eggs are laid in corn silks (top) and the larvae vary in color (bottom).

FALL ARMYWORM (*Spodoptera frugiperda*)

Fall armyworms cannot overwinter in areas where the ground freezes and, therefore, arrive in Michigan from the Gulf Coast states late in the growing season. The adult moth is dark gray with light and dark mottled wings and a white spot near the tip of the forewing. Eggs are deposited in clusters on leaves. The female covers her egg clusters with hairs and wing scales. The 1½-inch larvae vary in color, but all have three yellowish white lines running from head to tail and darker stripes on the sides of the body. Scattered along the body are black bumps (tubercles) with spines. A white inverted Y on the head capsule of the fall armyworm distinguishes it from other corn pests. Fall armyworm completes one to three generations per year.

Damage: Fall armyworm larvae feed on developing leaves deep inside the whorl, occasionally killing the tassel before it emerges, though usually a plant will outgrow fall armyworm whorl damage. Late in the season, larvae feed on developing ears, causing damage similar to that of corn earworm. Fall armyworm damage is generally more severe in late-planted corn and is uncommon in early plantings.

Control strategies for armyworm and fall armyworm:

- Eliminate grassy weeds from fields and field edges to reduce armyworm egg-laying sites.
- Avoid late-season plantings to reduce the risk of fall armyworm damage; fall armyworms can be more abundant in long-season hybrids.
- In warm, dry weather, natural enemies usually keep armyworm populations under control and provide some suppression of fall armyworms.
- If armyworms deplete the grassy weed hosts and larvae migrate into a cornfield, an insecticide application may be necessary. Spot treatment of infested areas can provide sufficient control for a confined infestation.
- Timing of insecticide treatments and application to the corn silks, where eggs are laid, are critical—once fall armyworms enter the ear, insecticide applications are not effective.

INSECT PESTS OF ONIONS

ONION MAGGOT (*Delia antiqua*)

Adult onion maggots emerge in mid-May and resemble houseflies. They feed on pollen from dandelions and other flowers. Female flies lay eggs in or on the soil near the bases of onion plants. When the eggs hatch, the maggots (larvae) burrow into the soil and feed on onion roots and bulbs. Onion maggots feed only on onion plants and prefer cool, wet weather. After feeding for two to three weeks, the maggots pupate in the soil. Adults emerge in a couple of weeks. There are three generations of onion maggots in Michigan each year.

Damage: Onion maggots feed on roots and bulbs. First-generation larvae cause the most damage, feeding on onion seedlings. Late in the season, adults prefer to lay eggs near already damaged plants. Maggots have a difficult time feeding on healthy bulbs.

Control strategies:

- Remove or plow under volunteer onions after harvest to reduce third-generation populations.
- Do not pile up old bulbs on field edges in the spring. This attracts adult females to lay eggs in the field.
- Plant onions as late as possible to reduce the time they are available for adult egg laying.
- Interplanting rye or barley strips in onion fields helps protect young seedlings from wind and attracts natural enemies.
- Avoid injuring plants when cultivating, fertilizing, or working in the field—onion maggots are attracted to injured plants.

- Natural enemies such as ground beetles, lady beetles, rove beetles, and tiny parasitic wasps attack and kill onion maggots. A fungal disease called *Entomophthora* kills adult flies.
- Onion maggots have developed resistance to nearly all available insecticides. Foliar applications aimed at killing the adults are ineffective, and, the application of foliar insecticides kills natural enemies and aids in resistance development.
- A soil insecticide application at planting protects against onion maggot.

ONION THRIPS (*Thrips tabaci*)

Onion thrips damage.

Thrips are small insects, measuring one mm in length, with two pairs of fringed, feathery wings. They have mouthparts developed for rasping and sucking – they shred plant tissue (rasp) and then withdraw the juices (suck). They feed on foliage, buds, and flowers of many host plants. Onion thrips prefer hot, dry conditions and require two to four weeks for complete development. There are several generations per year.

Damage: Thrips feed on the leaves and new growth in the center of the plant near the bulb. Damaged leaves have a silvery appearance. In heavy infestations, thrips can also be found feeding on the outer leaf surfaces, causing leaf tips to turn brown. Feeding injury reduces yield, decreases bulb size, and affects market price.

Control strategies:

- Thrips can be knocked off the plant or drowned by rain or overhead irrigation.
- Check plants regularly for early detection of thrips. They are usually found within the folds of leaves, where they are difficult to control with insecticides, and they have developed resistance to many common insecticides.
- When applying insecticides, use high pressures and high gallonage to improve coverage in the center of the plant.

INSECT PESTS OF POTATOES

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata*)

Colorado potato beetle larva (top) and adult (bottom).

Adult Colorado potato beetles are easily recognized by their yellow orange color and five narrow, black strips on each wing cover. Adults overwinter buried in the soil in fields and field borders. In the spring, they emerge and begin to feed, mate, and lay eggs. Typically, the yellow, oblong eggs are laid on the undersides of leaves in groups of 10 to 30. Red to orange larvae emerge and begin to feed on foliage. After two to three weeks of feeding, larvae pupate in the soil. Depending on the temperature, Michigan has one to three generations of Colorado potato beetle a year.

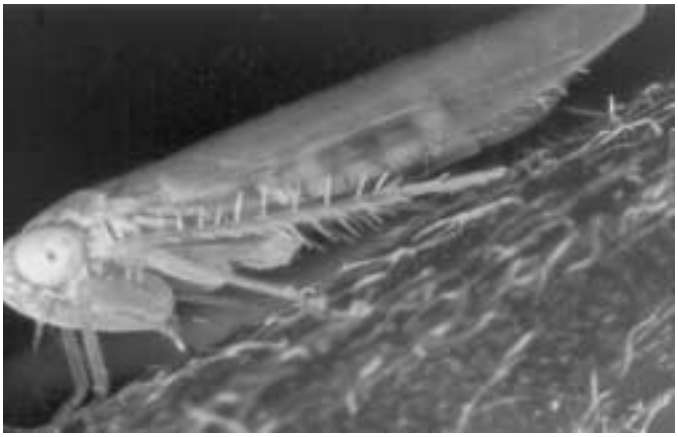
Damage: Colorado potato beetle adults and larvae feed on potato foliage. If left uncontrolled, they can easily defoliate entire plants.

Control strategies:

- Crop rotation to delay or reduce spring infestations is a highly effective management practice.
- Trap crops of early-planted potatoes along field edges concentrate adults migrating to the field. This high concentration of Colorado potato beetles makes flaming or vacuuming a successful control option.

- Several natural enemies aid in suppressing the Colorado potato beetle, but none provides adequate suppression.
- Soil- or foliar-applied insecticides can be used, though many Colorado potato beetle populations have developed insecticide resistance to almost all insecticides available.

POTATO LEAFHOPPER (*Empoasca fabae*)



Potato leafhooper adult.

Every year, potato leafhoppers migrate to Michigan from their overwintering sites in the southern United States, arriving in May. Potato leafhoppers are wedge-shaped, lime-green insects with sucking mouthparts. Potato leafhopper nymphs look like adult leafhoppers without fully developed wings. In warm weather, it takes only 21 days for a potato leafhopper to develop, so populations can increase quickly. There are multiple generations a year in Michigan.

Damage: Adults and nymphs damage plants by sucking plant sap from leaves; nymphs cause more damage than adults. Potato leafhoppers inject toxic saliva when they feed that causes the edges of damaged leaves to turn yellow and curl; eventually they die and drop from the plant. This damage is called "hopperburn." Potato leafhopper damage disrupts the plant's ability to transport nutrients and so reduces yield. A plant does not have to show obvious potato leafhopper damage, however, to suffer substantial yield loss.

Control strategies:

- Weekly scouting for potato leafhopper nymphs and adults is extremely important because low populations can cause significant yield reductions without obvious damage. Adults can be sampled by sweeping the field with a sweep net. To sample for nymphs, remove a single leaf and count the number of nymphs on the leaf. (Nymphs don't have wings and can't fly away). Randomly sample 25 leaves throughout the field.
- Foliar insecticides provide control. Choose foliar insecticides that do not promote Colorado potato beetle or green peach aphid resistance.

APHIDS

Green Peach Aphid (*Myzus persicae*) and Potato Aphid (*Macrosiphum euphorbiae*)

Green peach aphids are common pests of many vegetable crops. To learn more about the life cycle and crop damage caused by green peach aphids, see the carrot insect section.

The **potato aphid** has a similar life cycle as the green peach aphid. However, potato aphids overwinter in Michigan as eggs on plants of rose and related species. Beginning in June and July, winged potato aphids migrate to potato fields.

Damage: Aphids use sucking mouthparts to take plant juices from leaves and stems. If populations are large, they cause leaves to turn yellow and brown. Many aphid species can vector potato virus Y (PVY) and green peach aphids transmit potato leafroll virus (PLRV) (see Chapter 7-Disease Management).

Control strategies:

- Many common predators, including lady beetle adults and larvae, lacewing larvae, and syrphid fly larvae, feed on aphids. There are also a number of parasitic wasps. For seed potato producers, natural enemies usually do not provide sufficient aphid control because of the zero tolerance for virus infection.
- Sample for aphids by examining the undersides of leaves on plants throughout the field. Yellow sticky cards or water traps can also be used, but because many other insects can be trapped, correct pest identification can be difficult. Action thresholds differ for fresh market, processing, and seed potatoes.
- Aphids develop resistance quickly from repeated use of foliar insecticides with similar modes of action.

INSECT PESTS OF SNAP BEANS

POTATO LEAFHOPPERS

Potato leafhoppers are common pests of several vegetable crops. To learn more about their life cycle and the crop damage they cause, see the potato insect section.

TARNISHED PLANT BUG (*Lygus lineolaris*)

Adult tarnished plant bugs are 1/4 inch long and light brown with a tarnished appearance—relatively long antennae and legs, and a white triangle between their shoulders. Beginning in late April or May, tarnished plant bugs emerge from overwintering sites in leaf litter. Female bugs deposit eggs into plant stems and midribs. Eggs hatch, and nymphs, which are similar to the adults but smaller and without wings, begin to feed. There are three to five generations per year.

Damage: Tarnished plant bug adults and nymphs use their needlelike mouths to suck plant juices from leaves, flowers, and pods. Tarnished plant bugs inject a saliva that is toxic to some plants when they feed. In beans, they feed on flower petioles and cause blossom drop and

reduced yields. They feed on a wide variety of plants, including alfalfa, and can rapidly move from crop to crop. They may migrate into snap beans after the cutting of nearby alfalfa.

Control strategies:

- Begin scouting fields using a sweep net when plants are in bloom and continue through small pod development.
- With their wide host range (dozens of crops and weeds), there are no practical non-chemical control options at this time.
- Insecticide applications for potato leafhoppers also reduce tarnished plant bug populations, which move about freely, resuming feeding soon after an application.

EUROPEAN CORN BORER (*Ostrinia nubilalis*)

The European corn borer is a pest of snap beans. European corn borers overwinter as full-grown larvae in corn debris, usually field corn. Beginning in mid-June, the first generation of adult moths emerge and mate in tall grasses. The adult moths are cream to light brown. The female moth lays her eggs, which look like fish scales, on the undersides of corn leaves. The larvae hatch and feed on the leaf, eventually moving into and feeding down in the whorl. As the larvae mature, they enter the stalk to feed and pupate. After second-generation European corn borers adults mate, the females deposit eggs on the leaves in the ear zone of silking corn. The larvae feed on the developing ears, causing kernel damage, or enter the stalk, ear shank or cob. Depending on the temperature, there are two or three generations of European corn borer per year.

Damage: Young larvae feed on leaves, buds and flowers; mature larvae burrow into stems and beans. The greatest risk of European corn borer contamination is from bud to pin bean stage. Eggs laid 14 days or less before harvest will generally not result in damage or contamination. A very small proportion of European corn borer eggs survive long enough to lead to pod damage, but the tolerance for injury for processing is zero, and management is required.

Control strategies:

Non-chemical—A number of factors affect European corn borer populations but they are out of your control. A series of cool evenings (below 65 degrees F), or a heavy rain can reduce the number of eggs laid or the survival of small larvae. In addition, young larvae can dehydrate and blow away on hot, windy days. Thus, conditions present during European corn borer mating, egg laying, and development of eggs and small larvae are critical in determining the population from year to year.

Biological—A large number of natural enemies attack all life stages of European corn borer. Generalist predators such as lady beetle larvae and adults, lacewing larvae, and minute pirate bugs feed on egg masses and small larvae. Other insects and birds eat large larvae and pupae. In locations with large populations of predators, their role in controlling European corn borer should be taken into consideration when determining a management strategy.

Though parasitoids have been imported from Europe to control European corn borer, only a few have been successfully established. The amount of control from these parasitoids varies from year to year and depends on the location and shape of each field.

Two main pathogens affect European corn borer populations. *Beauvaria bassiana* is a naturally occurring fungus that usually kills overwintering larvae; dead larvae look white and furry. Most epidemics of *B. bassiana* occur late in the season during and after periods of rainfall when temperatures are in the mid-80's F. *Nosema pyrausta* is a protozoan-like microbe that reduces European corn borer egg laying, kills some larvae, and increases overwintering mortality.

Chemical—Timing is critical for a successful pesticide application. Larvae will be controlled only when they are moving on the plant and NOT after they are feeding inside the pods or stems. The treatment window for European corn borers is from bud stage to 14 days before harvest. Preventive insecticide applications are recommended for processing snap beans during this period.

INSECT PESTS OF TOMATOES

COLORADO POTATO BEETLE (*Leptinotarsa decemlineata*)

Colorado potato beetles feed on plants in the family Solanaceae, which includes potato, tomato, eggplant, nightshade, and horsenettle. For detailed information on their life cycle, see the section on potatoes.

Damage: Colorado potato beetle adults and larvae feed on tomato foliage and fruit. Though they prefer to feed on potatoes, they can easily defoliate an entire tomato plant in three to four days.

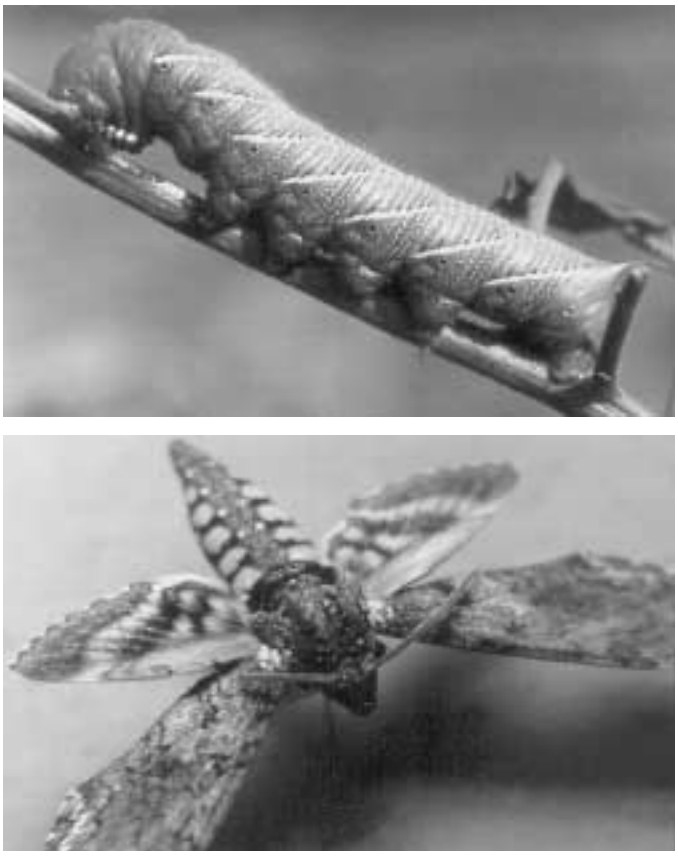
Control sÏtrategies:

- Crop rotation helps delay and reduce spring infestations.
- Trap crops of potatoes planted along field edges attract migrating Colorado potato beetle adults and delay tomato infestation for a few days.
- Several natural enemies aid in controlling the Colorado potato beetle, though they seldom provide sufficient larval or adult control.
- Foliar insecticides can be applied to trap crops or "hot spots," small isolated areas of infestation, to avoid treating an entire field. Insecticides are most effective on small larvae.

TOMATO HORNWORM (*Manduca quinquemaculata*)

Tomato hornworms can quickly defoliate plants because the larvae are large (up to four inches long). Larvae are pale green caterpillars with white markings and a horn at the rear end. In May or June, tomato hornworms emerge from their overwintering sites as adult

hawk moths. Single light green eggs are laid on the undersides of leaves. When eggs hatch, larvae feed on leaves and fruit before pupating in the soil. In Michigan, there may be two to three generations a year.



Tomato hornworm larva (top) and adult (bottom).

Damage: With their chewing mouthparts, these large caterpillars eat leaves of tomatoes, eggplants, and peppers and can also bore into tomato fruit. Tomato hornworm damage can cause 100 percent of the product to be unmarketable.

Control strategies:

- Small infestations of tomato hornworms can be hand picked from plants. Look closely when scouting plants for tomato hornworms -- they are well camouflaged and difficult to see until they are large enough to defoliate plants.
- A number of natural enemies help control tomato hornworms. For example, caterpillars parasitized by a tiny wasp will have tiny, white wasp cocoons on them. Parasitized larvae do not develop into adult hornworms, but they do continue to feed.
- Many foliar insecticides control tomato hornworms.

TOMATO FRUITWORM (*Heliocoverpa zea*)

The tomato fruitworm is also known as the corn earworm. The adult moth migrates into Michigan each year beginning in late June. Moths are active at night, and female moths are attracted to flowering and fruiting tomato plants. Small, yellow eggs are laid near or on the tomato. Newly hatched larvae vary in color from pink and green to maroon, brown, and tan and begin at once to feed on the tomato. A fully mature larva can grow to 1 3/4 inches long. Mature caterpillars drop from the plant and pupate in the soil. There are two to three generations per year in Michigan.

Damage: Tomato fruitworm caterpillars attack green tomatoes. They bore into the fruit, creating a deep, watery cavity. The cavity creates an entry point for secondary fungal infections. Damaged fruit is unmarketable and usually falls from the vine.

Control strategies:

- Naturally occurring biological control agents such as parasitic wasps and flies are very important in the control of tomato fruitworm.
- Tomato fruitworm adults can be monitored using pheromone lures and traps placed near tomato plants or cornfields. Scout fields to monitor fruit feeding. It is important to treat when the larvae are small, because once they enter the fruit, insecticide applications will not be effective.

GENERAL VEGETABLE INSECT PESTS

SEEDCORN MAGGOT (Delia platura)

Seedcorn maggots have a wide host range including corn, snap beans, and cucurbits. They overwinter in the soil as small, brown pupae. Beginning in early April, adult seedcorn maggots emerge. The adult is a small, gray fly, similar to a housefly. Female flies deposit eggs in the soil and are attracted to soil high in organic matter, either plowed-down crop residue or animal manure. Larvae or maggots feed on decomposing plant material and seeds. Seedcorn maggots favor cold, wet weather. There are multiple generations a year, but only the first generation is of economic concern.

Damage: Larvae feed on decomposing plant matter and seeds. Seeds can be attacked before or after germination. Damaged seeds may not sprout or produce malformed, stunted plants. Attacked seedlings will wilt and die within a few days.

Control strategies:

- If planting into a field that has a cover crop, plow down the cover crop three to four weeks before planting. This provides enough time for decomposition.
- Insecticide seed treatments are an effective way to control seedcorn maggot.

CHAPTER 5

Review Questions

Chapter 5: Insect Management

Write the answers to the following questions and then check your answers with those in the back of the manual.

1. Insect damage can result in:
   A. An unmarketable product.
   B. Disease transmission.
   C. Yield reduction.
   D. All of the above.

2. Molting is the process of shedding an old skeleton to reveal a new, larger exoskeleton.
   A. True.
   B. False.

3. Define metamorphosis.

4-8. Match the following forms of metamorphosis with the correct statement.

A. Simple

B. Complete

C. Both simple and complete

4. ___ Immature insects resemble adults.
5. ___ Adults and nymphs usually live in the same environment.
6. ___ Adult insects have wings.
7. ___ Immature insects do not look like the adults.
8. ___ Immature insects are referred to as larvae.

9. During which insect life stage does an insect undergo a complete change?
   A. Nymph
   B. Larva
   C. Pupa
   D. Adult

10. The asparagus miner goes through which type of metamorphosis?
    A. Simple
    B. Complete

11. The leafhopper goes through which type of metamorphosis?
    A. Simple
    B. Complete

12. Why is it important to understand an insect's life cycle for pest management?

13-17. Match the following insects with the correct statement below. Answers can be used more than once.

A. Diamondback moth
B. Aster leafhopper
C. Corn flea beetle
D. Onion thrips
E. European corn borer

13. ___ Transmits aster yellows.
14. ___ Pest of cole crops that can be resistant to *Bacillus thuringiensis*.
15. ___ Has rasping/sucking mouthparts.
16. ___ Transmits Stewart's wilt.
17. ___Feeds on leaves and burrows into cornstalks.

18. Larvae of the striped cucumber beetle damage cucumbers by feeding on the:

A. Fruit.
B. Root hairs and root tips.
C. Vines.
D. Foliage.

19. Which pest of asparagus feeds on the berries?

A. Common asparagus beetle
B. Asparagus miner
C. Spotted asparagus beetle
D. Cutworms

20. First generation European corn borers feed primarily in the:

A. Ear.
B. Shank.
C. Whorl.
D. Roots.

21. European corn borer feeding can result in:

A. Ear drop.
B. Stalk breakage.
C. Grain reduction.
D. All of the above.

22. The squash bug has what type of mouthparts?

A. Chewing.
B. Sucking.
C. Rasping.

23. Aphids and leafhoppers can spread plant disease.

A. True
B. False

24. Which insect pest of celery is also one of the main pest of cole crops?

A. Aster leafhopper
B. Cabbage looper
C. Tarnished plant bug
D. Variegated cutworm

25. Larvae of which of the following are common predators of aphids?

A. Lacewing
B Monarch
C. Housefly
D. None of the above

26. Which insect pest is easily confused with the striped cucumber beetle?

A. Bean leaf beetle.
B. Western corn rootworm
C. Corn flea beetle
D. Colorado potato beetle

27-30. Match the following insects with the characteristics given below.

A. Aphids
B. Armyworm
C. Tomato hornworm
D. Onion maggot

27. ___ Defoliates tomatoes, eggplants, and peppers.
28. ___ Vectors potato virus Y.
29. ___ Feeds on roots and bulbs.
30. ___ Damages corn and small grains.

31. Aphids must mate to produce offspring.

A. True
B. False

32. Which of the following insects does **not** have chewing mouthparts?

A. Tarnished plant bug
B. Diamondback moth larvae
C. Carrot weevil
D. Cutworms