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Protecting Field Corn from Insects and Nematodes

Michigan State University

Cooperative Extension Service

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Departments of Entomology and Botany and Plant Pathology

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Protecting Field Corn from Insects and Nematodes

By ROBERT F. RUPPEL, THOMAS A. DUDEK AND GEORGE W. BIRD

Departments of Entomology and Botany and Plant Pathology

CONTROL OF A PEST means the protection of a crop from that pest. This requires taking a preventative measure *before* the damage is done. This, in turn, means that growers must:

1. learn to identify the insects and nematodes that threaten the crop,
2. check the fields regularly for the pests, and
3. be prepared to apply control measures when they are needed.

This bulletin is intended to aid in these measures by describing the insect and nematode pests of corn for positive identification, by noting the damage of each pest and when it should appear in the field, by indicating the amount of damage or number of pests needed before a control measure is required and by recommending control measures for each pest.

We suggest you prepare for possible insect and nematode problems by first reading through the bulletin completely. Then reread the sections dealing with each pest, noting especially the type of equipment and pesticides that are recommended. With this in mind, check your equipment to be sure that it is adequate, and check with your dealer to be sure that you will be able to obtain the pesticide if it is needed. Remember, there will be little time between detecting a pest and the need to spray or implement some other means of control. It is advisable to spend a little time to be sure that you will not be delayed if a pest appears.

ANTICIPATING PROBLEMS

Insect damage is more severe when the insects appear unexpectedly and damage the crop before they are detected. Frequent checking of the field for insects will prevent such surprises.

Corn is especially susceptible to insect damage when it is small. Field checks should be especially frequent from the start of germination until the plants are fully established.

Some insects are most common in wet or weedy areas of a field. These areas should be checked more frequently for the insects than the rest of the field. Improved drainage, land fitting and weed control are in themselves beneficial to the crop, of course, and the reduced threat of insect damage is a bonus from these operations.

Other insects build up in adjacent fields of crops or weeds and then move into the corn. The crops to suspect are noted in the discussions on the specific insect pests. The insects do appear in corn fields remote from the suspect crops, but fields should be checked for them more frequently when the corn field is right next to the suspect crop.

SEVERITY VARIES

Nematode problems are usually most severe on light or sandy soils. There are several exceptions to this rule, however. Nematodes can increase to a damaging level on alternate crops or weeds. Problems with nematodes can also develop near ditch banks, and fields can become infested from soil on equipment previously used in other nematode-infested fields. Equipment used in an infested field should be thoroughly cleaned before it is used in an uninfested field.

Still other insects are most prevalent *following* certain crops. These crops, too, are noted in the discussion of the pests. Be especially alert to insects when corn is planted in old pasture or fields that had heavy weed growth. Rotation of corn with any other crop will avoid the problems

with corn rootworms and will help to suppress other insects and some diseases and weeds. We strongly recommend the rotation of corn whenever it is economically feasible.

The armyworm, European corn borer and other insects can appear in outbreaks; that is, heavy, widespread attacks. Your county agricultural extension agent is kept informed of the distribution and numbers of the pest and will alert you to any imminent problem. You can help by reporting any insect problem to him. Your notice could help identify a serious threat before it develops.

CONTROL MEASURES

With the exception of corn rootworms, the pests of corn are sporadic and scattered in their attacks. Their damage is often limited to only parts of a field. While nematodes cause limited losses of only 5-10 percent of the yield in many fields, losses of 20-60 percent occur in a limited number of fields or small areas within a field, for example. Pest damage is lessened by the sporadic damage, but we must stay alert to them.

Rotation, good drainage, land fitting and weed control will help in keeping the pests down. Good seed and proper fertilization also help reduce damage because they produce vigorous plants that can tolerate some feeding by the pests. Good farming practices aimed at full yields give the additional bonus of reduced pest problems.

Insects and nematodes can increase rapidly. They are subject to many natural enemies (parasites, predators and diseases) that, along with inclement weather and other factors, keep their numbers down. We notice the pests during the years when they are

numerous, but often fail to appreciate the role of the natural enemies in maintaining low pest numbers during most years. The natural enemies of pests are naturally occurring, and we have little control over their abundance. The combination of good cultural practices along with the natural enemies can reduce the numbers of many pests.

NATURAL ENEMIES

There are many different kinds of natural enemies of insects and nematodes. Some of the natural enemies themselves are insects or nematodes. We can destroy them along with the pest when we apply a chemical to control the pest. This can lead to a quick reoccurrence of the pest ("flare-up") or to the appearance of a second pest ("pest-swapping") because the natural enemies are killed. **Therefore, pesticides should be used only when they are clearly needed.** Pesticides are poisons and must be handled with full precautions. Extension Bulletin E-1025 "Safe, effective use of pesticides," available at your county agricultural extension office, outlines the steps in the safe use of pesticides. We recommend that you review this bulletin. Pesticides are also subject to strict regulations. These regulations are explained in Bulletin E-1025.

The best source of information on the specific pesticide that you plan to use is on the label of the pesticide container. **READ THE LABEL** carefully before you buy the pesticide to be sure that you can use it safely and effectively. The pesticides recommended for the control of the different pests are shown in Table 2. Please note that these recommendations are changed frequently. Your county agricultural extension agent is kept informed of the changes and should be consulted before you use the pesticide.

USING THE INSECT KEY

Proper identification of the pests is essential. Insect pests are usually scarce in corn except during outbreak years. They are present in low numbers every year, however, in all fields, especially in wet or weedy areas. We suggest that you spend a little time looking for the pests so that you will recognize them and their damage on sight. A quick listing of when to check for the different pests is pre-

KEY TO PEST IDENTIFICATION

A. Seedlings fail to germinate or seedlings wilt shortly after emergence:

1. Soft, fat grubs in soil near plants.....white grub
2. Hard, slender larvae in soil near plants.....wireworm
6. Seed or seedling tunneled by a headless maggot seedcorn maggot

B. Young plants cut at their bases:

3. Dark, cylindrical caterpillars near the bases of the plants cutworm

C. Young plants stunted, off-color or wilt quickly during dry weather:

1. Soft, fat grubs in soil near plants.....white grub
2. Hard, slender larvae in soil near plants.....wireworm
4. Roots pruned and tunneled by slender, white larvae
.....corn rootworm
- Stalk tunneled or with hole near base; cylindrical larva in stalk or in soil near plant
10. Light caterpillar with dark middle band.....stalk borer
3. Caterpillar variously colored but usually dark.....cutworm
18. Small off-color plants; roots stunted or deformed and may have small lesions on them; check with county extension agent for a root and soil sample.....nematode

D. Leaves of whorl-stage corn with parallel rows of holes across them:

7. Hard-shelled snout beetles in whorl or in soil near plant; holes usually small and circular.....billbug
- Caterpillars in whorl; holes usually large and elongate
12. White or pink, may have prominent black spots
.....European corn borer
5. Variously green to black with light stripe on each side
.....armyworm

E. Leaves with holes variously chewed through them or with feeding scars on them:

8. Irregular holes through leaves; slimy trails on leaves and soft, slimy animals in soil near plants.....slug
- Small, round holes and corky or whitish scars on upper sides of leaves
9. Small, black, active beetles on plants; usually on small plants
.....flea beetle

sented in Table 1. Your county agricultural extension agent will help you identify the pests.

The identification key has been prepared to aid you in recognizing the

A SPECIAL ALERT—If you find an insect feeding on corn but cannot identify it, turn it in to your county extension agent. There is always the threat of new pests. You could help meet this threat by keeping alert for strange insects and reporting them promptly.

insects and nematodes that are damaging to corn in Michigan. The key consists of eight major types of damage, each followed by short descriptions of the pests that can cause that damage. Some pests cause different types of damage and can "key-out" in more than one spot.

To use the key, read through all eight major types of damage and choose the one that best fits the problem that you are observing. Then read through the short description under that damage type to determine which pest is causing that damage. For

KEY TO PEST IDENTIFICATION

- 12. White caterpillars with black heads and sometimes prominent black spots on leaves or in whorl or leaf sheaths; whorl stage or later.....**European corn borer**
- Whitish scratches on upper surface of leaves
- 14. Active, blue beetles on leaves; late June or July.....**cereal leaf beetle**
- 11. Small, active, elongate insects in leaf sheaths; usually small corn.....**grain thrip**
- Margins of leaves eaten
- 5. Green to black caterpillars with light stripe down each side on plants or in soil near plants.....**armyworm**
- 15. Large, jumping insects on plants.....**grasshoppers**

F. Foliage yellowed or blackened:

- 11. Upper surface of leaf silvery; small, elongate, active insects in leaf sheaths.....**grain thrip**
- 16. Tassels and bases of leaves and ears with black coating; groups of small, inactive, greenish insects on plants.....**corn aphid**
- 19. Leaves yellowed; minute animals in silky webbing along vein on lower leaf surface.....**two-spotted spider mite**
- 18. Off-color plants without sign of insects; leaves may be curled and roots deformed; check with county extension agent for a root and soil sample.....**nematode**

G. Stalks or cobs tunneled:

- 12. White or pinkish caterpillar often with prominent black spots in tunnels.....**European corn borer**
- 10. Light caterpillar with dark middle band in tunnels; usually in stalk near base of plant.....**stalk borer**

H. Silks pruned or kernels at ear tip chewed:

- 13. Yellow to brown caterpillar with broad, light stripes in tip of ear.....**corn earworm**
- 17. Black beetle with short antennae (feelers) in ear.....**corn sap beetle**
- 4. Light-colored beetles with long antennae on silks; yellow-to-reddish with black stripes on wing.....**western corn rootworm**

I. Areas of small ears and stunted plants or uneven or poor yields; check with county extension agent for a root and soil sample

.....**nematode**

example, if silk or ear tips are damaged (H) the damage could be caused by corn earworm, corn sap beetle, or corn rootworms. Once you are sure of the identity of the pest, read the section in this bulletin that gives a

more complete description as well as the current control recommendations. The number in the key corresponds to the number of the section describing the pests.

from these eggs feed on the roots of grasses and on the roots of corn that may be later planted in these fields. The larvae can persist and cause damage for two years after the sod has been plowed down. The white grubs have white, thick, soft, cylindrical bodies and curl into a C-shape when



Larva of the white grub.

disturbed. They have a definite head, six small legs just behind the head and range up to 1½ inches in length. White grubs do not have fleshy legs near their rears. Further information on white grubs is given in Extension Bulletin E-737, "White Grubs in Field Crops," available from your county extension office.

Look for white grubs in plow furrows while fitting the land, and apply an insecticide if they are easily found. Check the roots of wilting seedling plants for feeding and the soil around each plant for the grubs. If there is still time, these affected areas and a margin around them may be disked, an insecticide applied and the area replanted.

Apply the insecticide as a spray or granule to cover the soil surface. Work the insecticide into the upper layer of soil immediately after application. It is a good practice to apply the insecticide just before final disking. Planting or replanting can be done immediately.

2. Wireworm

Adult wireworms (called click beetles) usually lay their eggs in grassy fields, sod, old pasture and weeds. The larvae that hatch from these eggs feed on the roots of the grasses and on the roots of corn that may be later planted in these fields. The larvae can persist and cause damage for two years after the sod has been plowed down.

Wireworms have tan, hard, thin, cylindrical bodies. They have a definite head and six small legs just behind the head. Wireworms do not have fleshy legs near their rears. Look for wireworms in plow furrows while fitting the land, and apply an insecticide if they are easily found. Check the



Larva of the wireworm.

FIELD CORN INSECT AND NEMATODE PESTS

1. White Grubs

Adult white grubs (called May beetles or June bugs) usually lay their eggs in grassy fields, sod, old pasture and weeds. The larvae that hatch

roots of wilting seedling plants for feeding and the soil around each plant for the worms. If there is still time, these affected areas and a margin around them may be disked, an insecticide applied and the area replanted.

Apply the insecticide in a 7-inch band over the row at planting time. An application may be applied to the affected area and a margin around it if the damage is found after planting. Cover the insecticide with soil immediately after applications. Planting or replanting can be done immediately.

3. Cutworm

Cutworms cut the stems or leaves of small plants and eat them. They will also gouge or even tunnel into the bases of the stalks of larger corn. They can be expected in fields that are weedy or poorly drained, but can also appear in any field. The cutworms are the larvae of the miller moths. They have a round, dark head, six small legs just behind the head and ten fleshy legs at the back end of their bodies. Their bodies are dark-colored, soft and cylindrical. They curl tightly when disturbed and may try to bite when handled; their bite is painless and harmless.



Larva of a black cutworm. There are several species of cutworms that are variously colored.

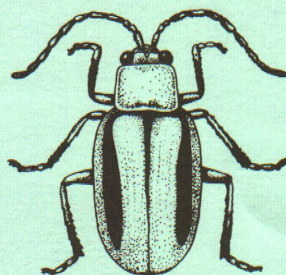
Cutworms cut the plants at night and hide in the soil surface near the plants during the day. Check fields every few days following germination for plants that are cut at their bases. Search the soil around the cut plants for the cutworms and apply an insecticide if 5 percent or more of the plants are cut or show signs of feeding. If not controlled, the large cutworms can destroy a stand very quickly. Do not delay applying an insecticide if it is needed. Apply insecticides, either as sprays or granules, in a band just wide enough to cover the plants.

4. Corn Rootworm

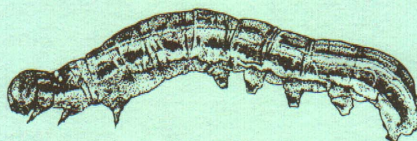
The corn rootworms are our most serious pests of corn. They can be pests, with rare exceptions, only when



Larva of a corn rootworm.



Adult of the western corn rootworm. The northern corn rootworm is similar in form, but is pale green or yellow without markings on the wings.



Larva of the armyworm.

corn follows corn without rotation. More detailed information on the rootworms is presented in Extension Bulletin E-736, "Corn rootworm." We urge you to obtain this bulletin from your county extension office if you have a continuous corn operation.

Biology—The oval, yellowish eggs of the rootworms overwinter in the soil and hatch when the soil warms up in spring. The larvae (or rootworms) that hatch from the eggs can feed only on corn. The larvae have a slender, whitish body with a tan head and six small legs just behind the head. They vary in size to $\frac{1}{2}$ inch long when fully grown. They tunnel and prune the roots of corn and reduce its vigor and yield. Their feeding can destroy enough of the roots that the corn lodges and pulls out of the ground at harvest. The lodging caused by rootworms tilts the corn right at soil level, and the stalks are usually gently curved (goose-necked) at their bases. The fully developed larvae become quiescent and transform to a resting stage (the pupa) in the soil in mid-June to late-July.

The adults emerge from soil in mid-to-late July and August. They are

hard-shelled beetles with long antennae (feelers) and are very active. There are two species: 1) the northern corn rootworm that is pale green to yellow without markings, and 2) the western corn rootworm that is yellow-to-reddish with three stripes down its wings. The stripes on the western may be reduced to spots near the base of the wings or enlarged and fused to make the whole wing black.

The adults feed on the silks and tassels of corn and the westerns also feed on the leaves. Their feeding on the silks can reduce pollination. The adults move out of corn fields when the corn begins to dry and feed on the flowers of other plants and weeds. The adults persist in the fields until the first heavy frost. They lay their eggs in the upper layer of soil almost exclusively near the bases of corn plants. The eggs remain quiet in the field until the following spring.

Detection—The larvae feed hidden on the roots in the soil, and their damage is too often not noted until the corn lodges in late summer. Their damage can be anticipated, however, by checking the corn in the field the preceding season. We urge you to check the field for adults if corn is to be planted in the field the following year. You can do this by: 1) going into the field beyond the margins and headlands in August, and 2) counting the number of adults that you can see on 160 plants in a row of corn. If there are 130 adults or more per 160 plants, the field should be rotated to another crop or treated with insecticide if corn is planted again.

Lodged, mature corn can also be checked to see if rootworm is the cause of the lodging. The goose-necking typical of rootworm damage is a good indication, and the roots and brace roots should be checked for pruning and tunneling to be sure that the lodging was caused by rootworms. Protection of the following year's corn is needed if the rootworm lodging is found in the field.

The feeding of the larvae can cause stunting and wilting of the young plants. Check the roots and the soil around small plants in wilted or stunted areas for the larvae and their tunneling. A post-emergence application of insecticide can be applied to control the larvae if detected by mid-to-late June.

Control—The adults' clipping of silks can reduce seed set. Corn, especially if retarded by late planting or drought, should be checked for adults when the first silks appear. A spray of insecticide should be applied if there are four or more adults per ear and pollination has not occurred. The sprays can be applied by air or with high-clearance ground rigs.

The rootworm adults lay their eggs near corn plants, and the larvae can feed only on corn. This means that the rootworms are pests *only* where corn follows corn. Rotation of corn with any other crop is strongly recommended where it is economically feasible.

Soil insecticides can be applied to protect the corn in a field threatened by rootworms. The insecticide should be applied as a spray or as granules in a 7-inch band centered over the row. The insecticide can be applied at planting time or as a post-emergence (or lay by) application in June. Special care must be taken to keep the insecticide out of contact with the seed; be sure that the proper amount of insecticide has been applied, and cover the insecticide with some soil immediately after application.

5. Armyworm

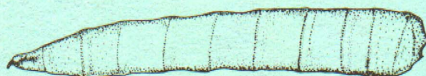
Armyworms are closely related to cutworms. The armyworms have cylindrical bodies, definite heads, six small legs just behind the head and ten fleshy legs near the rear end. They are usually dark with a prominent light stripe down each side. Armyworms normally feed and build up in numbers on grasses and small grains. They can build up to large numbers on weed grasses under corn. They will "march" into fields of other crops when they are abundant and can cause damage to corn. They feed on the leaves and leave sawdust-like droppings (frass) under the plants. They feed mostly at night, and the worms usually hide in the surface of the soil during the day.

Fields, especially those near grain or grassy fields or fields with weed grasses in them, should be checked for chewed leaves, frass and the armyworms on the leaves or in the soil near the plants. Armyworms are heavy feeders and can quickly damage crops. A spray should be applied as soon as possible after infestation has been detected. Armyworm infestations are

often very widespread. Notify your county agricultural extension agent when you find them so that he can warn your neighbors about the threat. Further information can be found in Extension Bulletin E-755, "Armyworms in Field Crops," available at your county extension office.

6. Seedcorn Maggot

The seedcorn maggot is a whitish, spindle-shaped larvae that lacks both definite head and legs. Maggots tunnel into the seed and the stems of seedlings. Their damage appears as areas of poor stand or as weak, wilting seedlings.



Larva of the seedcorn maggot.

The adults are small flies that lay their eggs in soils high in organic matter (muck soils or fields with a lot of weeds, stubble or manure that have been plowed down). Maggots hatching from these eggs damage the corn. Late-planted corn is especially susceptible to seedcorn maggot.

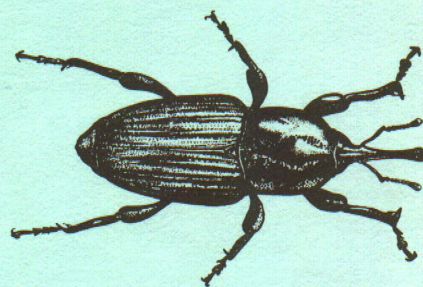
Start looking for areas of poor stand as soon as the corn begins to germinate. Check the seed and stems of the seedlings for the maggots.

Treatment of the seed with an insecticide is recommended for control of the seedcorn maggot. Seed treatment is best done by the seed dealer at the same time the seed is treated with fungicide. Seed treatment formulations of the insecticide are available for use in planting box applications if ready-treated seed is not available. Follow the instructions on the label of the seed treatment material to be sure to get even coating on the seed.

7. Billbug

Billbugs are usually most abundant in weedy areas of the field or margins along the sides of seedy fields. The billbugs are hard-shelled snout beetles. There are two types: one is large, black and often found hiding in the soil near the plant; the other is smaller, gray and usually found deep in the upper whorl of leaves of the plant. The larvae are small, white worms with a definite head but no legs.

The larvae can tunnel through the stalk and feed on the roots in the soil.

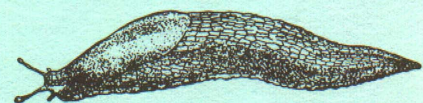


Adult of the corn billbug. There are several species of billbugs that vary in color.

The damage done by the larvae is slight, but feeding by the adult in the whorl can kill the bud of the plant. The feeding of the billbug adults in the whorl causes rounded, parallel holes to appear on the leaves as the leaves unroll out of the whorl. Check fields for the feeding of the adults in the whorls of the corn. Apply an insecticide as a spray or granule if one-third or more of the plants show damage.

8. Slugs

Slugs are not insects. They are mollusks, related to the clam, snail and octopus. Slugs are most damaging in wet, weedy fields or areas of a field. They feed at night by chewing irregular holes through the leaves of the corn and hide during the day in the soil near the bases of the plants. The holes in the leaves and their slimy trails on the leaves are easily seen dur-

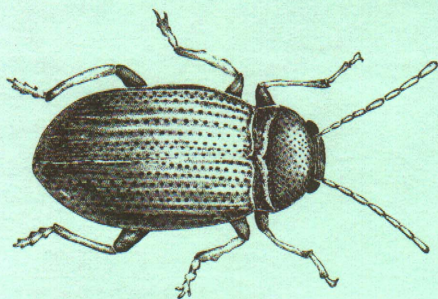


A slug.

ing the day. A search of the soil and debris near the plants will reveal soft, dark, slimy, rounded-to-elongate animals that range from ½ to 1½ inches long. Slugs have been most abundant during cool, moist springs and are often damaging only in the wetter areas of the field. They can severely damage small plants when abundant. Thus, a spray should be applied to the area affected if their damage is seen on most plants.

9. Flea Beetle

Flea beetles are small, round, dark-colored, hard-shelled beetles that spring into the air when disturbed. The larvae of these beetles live on the roots of grains, grasses and some



Adult of the flea beetle. There are several species of flea beetles that vary in markings.

weeds. Flea beetles can be expected in corn fields that are weedy or close to grain fields. They are active insects, however, and may appear in any field. Flea beetles eat small, round, "shot-holes" completely through the young leaves of corn or feed on the upper surfaces of the leaves, causing a round, corky spot on the leaf. Their feeding retards the early growth of the plant and can kill small plants when beetles are numerous. In addition to the direct damage to corn, the flea beetles also carry the bacteria of Stewart's wilt disease of corn. Apply a spray to the area infested when most of the plants in the area show signs of feeding by the flea beetles.

10. Stalk Borer

Stalk borers are cylindrical worms with three pairs of jointed legs near the head and five pairs of fleshy legs near the tail. They are readily identified by the broad, dark, "saddle" marking across the middle. The larvae

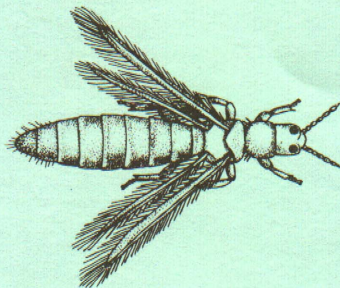


Larva of the stalk borer.

tunnel into the bases of the stalks and cause stunting or death of the plants. Their holes in the stems are marked by silky webbing and sawdust-like casting called frass. The borers are most damaging to small plants early in the season. Check fields of young corn for the larvae and their frassy holes. Apply an insecticide as spray or granule when about 5 percent or more of the plants show damage from this pest.

11. Grain Thrip

Grain thrips are very small, ovoid, yellowish-to-reddish insects that scrape the upper surfaces of the leaves and suck up the juices. The thrips feed hidden in the leaf sheaths of the small plants. Their damage appears at first as silvery on the upper surface of the leaves. Heavily damaged leaves dry up, and the whole plant is stunted and retarded in growth when the thrips are abundant.



Adult of the grain thrips.

Thrips are usually found in grassy areas of the field (headlands for example), but can spread out and damage entire fields during dry weather. Apply a spray to small corn when most of the plants in an area show the silverying of the leaves caused by grain thrips.

12. European Corn Borer

The scale-like, rounded eggs of the European corn borer are laid in masses on the underside of corn leaves. The eggs overlap as mass-like shingles on a roof. They are whitish when first laid, but darken and form a definite black spot (the head of the larvae) just before hatching. The larvae make small white spots by feeding on the upper surface of the leaves soon after hatching. They move into the whorl within a day or so, and their presence in the whorl can be detected by the frassy droppings and parallel, elongate holes that appear in the leaves. The



Egg mass of the European corn borer.

whorl damage looks the same as armyworm damage.

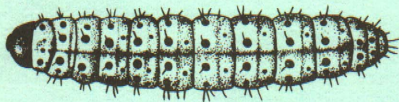
The European corn borer larvae have the same cylindrical shape as the armyworm and also have six small legs near the head and five pairs of fleshy legs near the tail. Larvae of the European corn borer, however, are whitish and usually marked with prominent, dark brown or black spots in contrast to the marked, striped appearance of the armyworm.

Larvae of the borer leave the whorl after a few days and tunnel into the stalks and even into the ear shanks of the corn. Their tunneling weakens the stalk, and the damaged corn lodges, making harvesting very difficult. Stalks damaged by European corn borer break over at an upper internode, usually not at the base as they do when damaged by corn rootworms. Lodging is most damaging, of course, when the stalk is broken below the ears. Larvae pupate within the stalk, and adults emerge from the pupae.

There are two generations of the borer per year in Michigan. Larvae overwinter in corn stubble and many other plants. They pupate early in the spring, and adult moths emerge to lay the eggs of the first generation in June. Adults are active only at night. They are attracted to light, and light traps are maintained in many areas to check the abundance of the moths. The adults of this first generation emerge and lay eggs of the second generation in August. It is the larvae of the second generation that pass the winter in an inactive state.

Several corn hybrids are resistant to the first generation of the borer. Use of a resistant hybrid is strongly recommended. Your county agricultural extension agent can advise you on resistant hybrids suitable for your area.

Be alert to notices from county agricultural extension agents of the appearance of the adult European corn borer moths caught in the light traps. This will warn you when to check the fields. When you check the fields, also examine the undersides of the corn leaves for egg masses, check the upper surfaces of the leaves for white spots made by the small larvae, and examine the whorl for frass and larvae. An application of insecticides is needed when there is about one egg mass



Larva of the European corn borer.

per plant or when $\frac{3}{4}$ of the plants show damage of the larvae.

European corn borers are easily controlled when the small larvae are exposed on the surface of the leaves, more difficult to control when the larvae are in the whorl, and cannot be controlled when the larvae are tunneling in the stalk. The field must be checked frequently in order to time the applications to assure protection of the corn from the borer.

The ideal time to spray is when the eggs are in the "black head" stage. They will hatch soon, and the small larvae will be entirely exposed to the spray. Granular insecticides or a spray applied as described for armyworm control are needed when the larvae are in the whorl. The corn will be tall when the second generation borer appears. An aerial application or a ground application with a "Hi-Boy" type of applicator will be needed. Further information on this pest can be found in Extension Bulletin E-584, "European Corn Borer," available from your county extension office.

13. Corn Earworm

Corn earworms are rarely damaging to field corn in Michigan. They can



Eggs of the corn earworm.

appear some years, however, and we should stay alert for them.

Corn earworms are cylindrical worms with a tan head, six small legs behind the head and five pairs of fleshy legs near the tail. They range in color from pale green and reddish brown to nearly black. They have light stripes running the length of their bodies and range up to 2 inches in length.

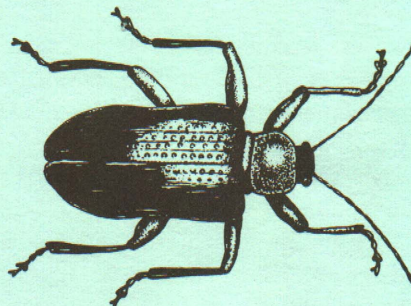


Larva of the corn earworm.

Adult moths lay greenish, cone-shaped eggs singly on the silks of late-planted corn. The young larvae that hatch from these eggs feed on the silks and soft seeds near the tops of the ears. Check for eggs on the silks of field corn that was planted very late, and apply a spray to corn if the eggs are found on most of the silks.

14. Cereal Leaf Beetle

Cereal leaf beetles are severe pests of small grains, but the adults can damage young corn also, especially when it is planted next to a heavily infested grain field. Adult cereal leaf beetles are small, active, hard-shelled beetles with blue wing covers and red pronotums (necks). They emerge from the grain crops during mid-June to early-July and may enter fields of corn grown next to the grains. Their feeding on corn appears as a whitish scratching on the leaf surface. The scratches fuse, and the leaf tatters and dries when the adults are numerous. Their feeding on corn is of importance only if the adults are abundant and the corn is still small.



Adult of the cereal leaf beetle.

A spray of insecticides is needed only if their damage threatens to retard the growth of the small plants. More information on this pest is available in Extension Bulletin E-738, "Cereal Leaf Beetle Control," available from your county extension office.

15. Grasshoppers

The well-known grasshoppers are normal residents of corn fields and rarely appear in large enough numbers to justify the use of insecticides for their control. Most common in corn are the large, gray to green, differential grasshoppers. They chew large areas out of the margins of corn leaves and are generally most abundant in the margins of the fields adjacent to weedy fields and fence rows. Check corn fields for grasshoppers and their leaf-feeding during periods of drought. Give special attention to the margins of fields adjacent to large, weedy

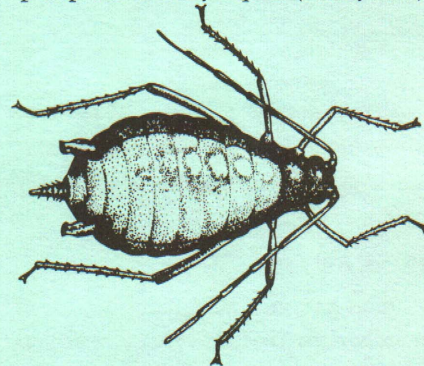


Adult grasshopper.

areas, and apply an insecticide only if grasshoppers are especially abundant. Notify your county agricultural extension agent if you see damaging numbers of grasshoppers. Insecticides may be applied either as sprays or granules.

16. Corn Leaf Aphid

Corn leaf aphids are small, inactive, green insects that suck the juices of corn. Found in colonies, most commonly in the tassels, leaf sheaths and bases of the ear, their feeding can retard the growth of the plant and result in poor seed set on the ear. Aphids pump out a sticky liquid (honeydew).



Wingless corn leaf aphid. Winged forms of this species are also common.

A mold forms on this honeydew and gives heavily infested plants a blackened appearance.

Corn leaf aphids are commonly found in all Michigan corn fields. Natural enemies (lady beetles, lace wings, diseases and wasplike parasites) usually keep their numbers below damaging levels. A spray is needed to control corn leaf aphids only in fields where the seed has not been set, and nearly every plant shows appreciable blackened areas of honeydew in the tassels and axils of the leaves. Corn will be tall when the insecticide is applied. An aerial spray or a ground application using a "Hi-Boy" type of sprayer is needed.

17. Sap Beetle

Sap beetles (also called "picnic beetles") are hard-shelled black beetles that are spotted with yellow or red. They feed primarily on injured, decomposing tissues. They are frequently found in whorls of corn that have been damaged by armyworms or European corn borer and in the tips of ears damaged by birds or the corn earworm. When abundant, they will



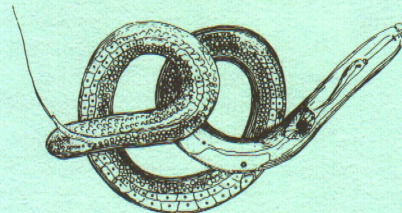
Adult of a sap beetle.

feed on soft, sound kernels in the ear, but their damage is negligible. They are of special importance because they feed on tissues that have been damaged by other causes and are frequently falsely accused of doing the damage. Their appearance in large numbers in a corn field is a good indication that the corn is in poor condition because of injuries from other insects, diseases or other causes.

18. Nematodes

Plant-parasitic nematodes are small roundworms that live in the soil and feed on the roots of plants, including field corn. Nematodes are not insects;

they belong to a separate group of invertebrate animals known to cause diseases of animals (dog heartworm),



Root-lesion nematode.

man (trichinosis and elephantiasis) and plants (root-knot nematode disease of tomatoes and cyst nematode disease of sugar beets). Nematodes can also be vectors of viruses and serve as predisposition agents (alter the physiology of plants, increasing their susceptibility to disease caused by fungi and bacteria). Many types of nematodes, however, are beneficial.

It has been found that several kinds of plant-parasitic nematodes significantly reduce yields of field corn grown in Michigan and other states throughout the Corn Belt. Nematodes are present in many corn fields, and in high-enough population densities to cause damage in some fields. They feed in or on the roots and prevent normal growth and development. This inhibits optimum uptake of water and nutrients and results in stunted plant growth and decreased yields.

Damage to field corn caused by plant-parasitic nematodes can be observed throughout most of the growing season. Diseased plants appear stunted and off-color early in the growing season. By mid-season, the plants remain stunted, wilt and have deformed or underdeveloped root systems. Late in the growing season, nematode-infested fields have areas containing stunted plants, underdeveloped ears and uneven or poor yields.

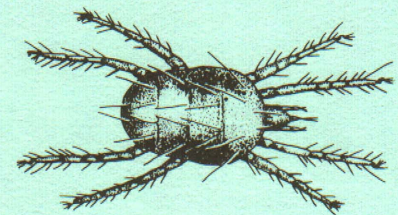
Plant-parasitic nematodes are microscopic. The only way to confirm that nematodes are responsible for reduced yields in a specific corn field is to have soil and corn roots checked for the presence of nematodes. This is done by the Michigan Cooperative Extension Service Nematode Diagnostic Laboratory (see Extension Bulletin E-800). Contact your local extension

agent for additional information about nematode sampling procedures, submission of samples, interpretation of results and nematode control strategies.

Five types of plant-parasitic nematodes reduce yields of field corn in Michigan. Root-lesion (*Pratylenchus penetrans*) and stunt (*Tylenchorhynchus dubius* and *T. nudus*) nematodes are commonly associated with yield losses in problem fields or problem areas within fields. Dagger (*Xiphinema americanum*), lance (*Hoplolaimus galeatus*) and needle (*Longidorus longicandatus*) nematodes cause significant losses in a number of widely scattered corn fields throughout Michigan.

19. Two-Spotted Spider Mite

Mites, like many other pests, are rarely a problem on corn in Michigan. But, they can be damaging during some years, and we should stay alert for them. Mites have many hosts and are usually most abundant in weedy



A two-spotted spider mite.

areas or near weedy margins. Therefore, weedy areas should be checked especially carefully for mites during dry periods. They have been most damaging during dry summers.

Mites are eight-legged animals more closely related to spiders than insects. They are extremely small and can be seen only as tiny, active spots on the undersides of the leaves. They are rounded and are pale white, greenish or reddish in color. They spin fine silken threads and web the undersides of the leaves, especially along the midrib, as they move. They feed by sucking the sap. Their feeding causes a yellowish or bronzing of the leaves and finally a drying of the leaves. Look for the yellowing and webbing under the leaves and apply an insecticide when damage is first easily found.

Table 1 — Guide to checking corn fields for insect and nematode pests.

<i>When to look</i>	<i>Where to look</i>	<i>What to look for</i>	<i>Pest</i>
Previous corn	Corn in field	Adults and lodged corn. Areas of poor stand.	Expect corn rootworm. Expect white grub, wireworm, seedcorn maggot. Expect nematode.
Before planting	Adjacent fields	Stunted corn; have soil and root samples made. Small grains, weedy or grassy fields.	Expect armyworm, flea beetle, billbug, cutworm, slug, grasshopper, grain thrip, cereal leaf beetle, stalk borer.
	Corn field	Wet or weedy spots; previous sod or meadow in past 2 seasons. Muck soil, heavy weeds or stubble, heavy manure.	(The pests above.) Expect white grub, wireworm. Expect seedcorn maggot.
Land fitting	Plow furrows	Thick-bodied larvae. Slender, hard larvae.	White grub. Wireworm.
Germination	Areas of poor stand	Roots pruned or seed gnawed. Seed or seedlings tunneled by legless maggots.	White grub, wireworm. Seedcorn maggot.
Seedling and whorl stage	Leaves	Plants cut at soil level. Irregular holes in leaves; soft slimy animals in soil. Small white spots on upper surface; white cylindrical larvae in leaves or whorl. Small round holes and corky spots; small active beetles on leaves. Silvering of upper leaf surface; small, active reddish-to-yellowish insects in bases of leaves. White scratches on upper surface; blue beetles on leaves. Holes in leaves and "sawdust" in whorl: a. a hard-shelled snout beetle in whorl or soil. b. striped, cylindrical worms in whorls, leaves or soil. c. clear or spotted cylindrical worms in whorl.	Cutworm. Slug. European corn borer. Flea beetle. Grain thrip. Cereal leaf beetle.
	Stunted or wilted plants	Roots pruned and tunneled by small white larvae. Roots stunted; may have dark lesions; soil sample. Base of stalk tunneled or gnawed; cylindrical larvae near or in plants a. larvae light with dark middle back. b. larvae dark.	Billbug. Armyworm. European corn borer. Corn rootworm. Nematode.
Tasseled plants	Leaves	Margins eaten: a. large active insects on plants. b. striped cylindrical worms on plants or in soil. Small, white spots on upper surface; white cylindrical larvae on leaves or leaf sheaths. Leaves yellowed or bronzed; silky webbing under leaves.	Stalk borer. Cutworm. Grasshopper. Armyworm. European corn borer. Two-spotted spider mite.

Continued on page 10

Table 1. (Continued)

<i>When to look</i>	<i>Where to look</i>	<i>What to look for</i>	<i>Pest</i>
	Bases of leaves, ears and tassels Tassels, silks and ears	Black, sticky honeydew; small, soft green insects on plants. Hard-shelled, active beetles with long antennae (feelers): a. pale green or yellow; unmarked. b. yellow-to-reddish; black stripes on wings. Striped cylindrical larvae. Clear or spotted cylindrical larvae. Hard-shelled beetles with short antennae (feelers); black with red or yellow spots.	Corn leaf aphid. Northern corn rootworm. Western corn rootworm. Corn earworm. European corn borer. Sap beetle.
Mature corn	Stunted areas	Roots stunted; have root and soil samples made.	Nematode.
	Lodged areas	Roots pruned and tunneled. Stalk tunneled and broken above ground level; clear or spotted cylindrical larvae in base of stalk.	Corn rootworm. European corn borer.

Table 2 — Insecticides recommended for insect control in field corn.

<i>Insect</i>	<i>Type of application</i>	<i>Insecticide</i>	<i>Amount active insecticide</i>	<i>Limits*</i>
Seedcorn maggot	Seed treatment	diazinon	2 oz/bu seed	Do not use seed for feed or food.
Seedcorn maggot	Soil, broadcast† Soil, 7" band†	diazinon Dasanit Dyfonate Counter	4 lb/A As used for corn rootworm larvae; will aid in seedcorn maggot control. As used for corn rootworm larvae; will aid in seedcorn maggot control. As used for corn rootworm larvae; will aid in seedcorn maggot control.	Apply before planting.
Nematodes	Soil, 12" band	Furadan	2 lb/A	Apply at planting.
Wireworm	Soil, broadcast† Soil, 7" band† Soil, 7" band†	diazinon Mocap Counter Thimet	4 lb/A 1 lb/A As used for corn rootworm larvae; will aid in wireworm control. As used for corn rootworm larvae; will aid in wireworm control.	Apply before planting. Apply at planting.
White grub	Soil, broadcast†	chlordane parathion	4 lb/A 3 lb/A (mineral soils) 4 lb/A (muck soils)	Apply before planting. Apply before planting. Apply before planting.
Corn rootworm larvae	Soil, band†	Lorsban Counter Dasanit Furadan Thimet Dyfonate Mocap diazinon	1 lb/A 1 lb/A 1 lb/A 0.75 lb/A 1 lb/A 1 lb/A 1 lb/A 1 lb/A	Apply at planting. Apply at planting. Apply at planting or post-emergence in June. Apply at planting or post-emergence in June. Apply at planting or post-emergence in June. Apply at planting or post-emergence in June. Apply at planting or post-emergence in June. Apply at post-emergence in June.
Grasshopper	Foliage	malathion ULV malathion diazinon	1 lb/A 8 liq. oz/A 0.50 lb/A	5 days 5 days 10 days

Table 2. (Continued)

<i>Insect</i>	<i>Type of application</i>	<i>Insecticide</i>	<i>Amount active insecticide</i>	<i>Limits*</i>
Aphid	Foliage	diazinon	1 lb/A	10 days
		Di-Syston	0.50 lb/A	28 days
		Meta-Systox R	0.50 lb/A	7 days; 1 application per year.
		malathion	1 lb/A	5 days
		Phosdrin	0.50 lb/A	1 day
Cutworm	Foliage	Sevin	2 lb/A	0 days
		diazinon	2 lb/A	10 days
		Dylox	1 lb/A	0 days
		Mocap	As used for corn rootworm larvae; will aid in cutworm control.	
		Lorsban	As used for corn rootworm larvae; will aid in cutworm control.	
Armyworm	Foliage	Sevin	2 lb/A	0 days
		diazinon	2 lb/A	10 days
		Dylox	1 lb/A	0 days
		malathion	1.50 lb/A	5 days
		methomyl	0.5 lb/A	3 days
Billbug, slugs, flea beetle or stalk borer	Foliage	Sevin	1 lb/A	0 days
Grain thrips	Foliage	Sevin	1 lb/A	0 days
		Di-Syston	0.50 lb/A	28 days; only 2 applications per year.
		Meta-Systox R	0.38 lb/A	7 days
		malathion	1 lb/A	5 days
European corn borer	Foliage	diazinon	1.50 lb/A	12 days for forage; 0 days for grains.
		parathion	0.50 lb/A	12 days
		Furadan	1 lb/A	Do not apply if Furadan at more than 1 lb/A had been applied to the soil; no more than 2 applications per year.
Corn rootworm adults	Foliage	malathion	1 lb/A	5 days
		ULV malathion	4 liq. oz/A	5 days
		diazinon	0.50 lb/A	0 days
		Sevin	1 lb/A	0 days
Corn earworm	Foliage	Sevin	2 lb/A	0 days
		malathion	1.50 lb/A	5 days
		parathion	0.50 lb/A	12 days
Cereal leaf beetle adults	Foliage	malathion	1 lb/A	5 days
		ULV malathion	4 liq. oz/A	5 days
Two-spotted spider mite	Foliage	Meta-Systox-R	0.50 lb/A	7 days
		parathion	0.50 lb/A	12 days

*The number of days refers to the time between application and harvest. Note that the use of chlordane is recommended for non-dairy farms only; the other insecticides can be used on dairy farms.

†Cover all soil-applied insecticide with soil as soon as possible after application. Spread "broadcast" applications to cover the entire soil surface. Apply "7-inch band" applications in a 7-inch wide band centered over the row. The amount of active insecticide cited for band application is for 40-inch row. The amount to be used when other row widths are used must be adjusted using the equation:

$$\text{adjusted amount} = \frac{40A}{W}$$

where A is the amount cited in the table and K is the row width, in inches, to be used. For example, if 1 lb/A is cited in the table and a 32-inch row width is to be used:

$$\text{adjusted amount} = \frac{40 \times 1}{32} = 1\frac{1}{4} \text{ lb/A}$$

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