

By Robert F. Ruppel and Thomas A. Dudek, Department of Entomology

THE NORTHERN CORN ROOTWORM has long been a pest of corn in Michigan. The western corn rootworm (Figure 1), a very similar species, entered the state about 1969 and is now also well established as a pest. Both of these insects, with rare exceptions, damage **only** corn that is grown without rotation, a common practice in Michigan. The numbers of both of these species have increased during the past few years. We must stay alert for these pests in order to protect corn from their damage.

BIOLOGY

The western and northern corn rootworms are very similar in biology. Adult beetles of the rootworms emerge from the soil in July and August. They are very active and hard to catch. They can be distinguished from nearly all other hard-shelled beetles found in flowering corn by their long antennae (feelers; see Figure 1). The western corn rootworm adults are yellow to reddish with three black stripes down their wings. The stripes may be reduced to spots near the wing bases or may be fused to make the whole wing black. The northern corn rootworm adults are pale green or yellow with unmarked wings.

Both species feed on the silks, tassels and soft kernels at the tips of the ears. The western corn rootworm also feeds on the leaves. Their feeding on the early silks can result in a poor grain set. They lay oval, yellowish eggs in the soil almost exclusively near the bases of corn plants. The adults are abundant in corn while it is flowering, and they leave the field to feed on the pollen of a number of other plants when the corn matures. They are active until the first hard frost of the fall.

The eggs overwinter in the field and hatch when the soil warms up in the spring. The larvae (rootworms) that hatch from these eggs are slender, cylindrical, white in color and have a tan head with six small legs just in back of the head. The larvae vary in size up to ½ inch when fully grown. The larvae tunnel and prune the roots of corn and can feed only on corn. Their feeding can destroy the roots (Figure 2) and reduce the vigor of the plant. The damaged roots cause the stalks to lodge and pull

out of the ground at harvest time, making mechanical harvesting difficult and increasing harvest losses. The lodging caused by the rootworm starts at soil level, and the plants are commonly curved (goose-necked) at their bases (Figure 3). The larvae transform to a quiet stage (the pupae) in the soil in mid-June to late-July, and the adults emerge from these pupae. There is only one generation per year.

DETECTION

Rootworm larvae damage roots in the soil. Too often their damage is not detected until the corn lodges in late summer. The threat of damage can be reduced by checking your fields for the pests. There are several times during the season when the fields should be checked for the rootworm.

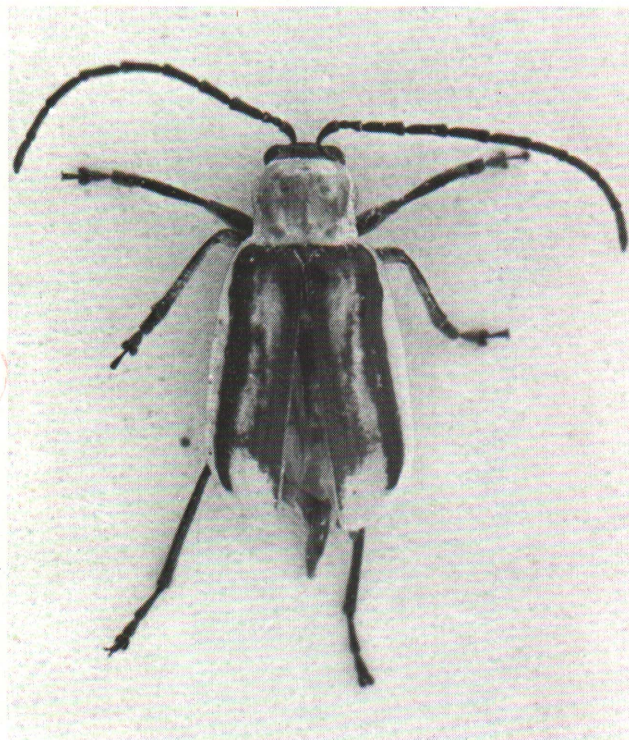


Figure 1. The western corn rootworm adult (above) is yellow with black stripes down its wings. The northern corn rootworm is pale green or yellow without striping. Both the northern and western corn rootworm adults have long antennae (feelers).

Early Root Damage

Examine the roots of plants for larvae and their tunneling in areas of small corn that are stunted or wilted. Other insects, root rots or some soil problems cause similar symptoms, so check carefully for the slender larvae in the roots or in the soil. A post-emergence application of an insecticide (see Table 2) may be applied if the larvae are detected in time.

Silks

The adults can reduce grain set if they are abundant and pollination has not yet occurred. Check fields for the adults, starting when the plants start to silk. Pollination usually occurs within 3 to 4 days after silks appear. The silks wilt and dry shortly after pollination. A spray of insecticides (see Table 1) is needed if there are four or more adults per ear and pollination has not occurred. Late planted corn or corn retarded by drought are most susceptible and should be checked especially well for the adults.

Adults

The number of adults in a field in late July and August is a good index of the threat the rootworms pose in that field the following year.

We strongly recommend that all corn be checked for adults in August if corn is to be planted in that same field the following year. In past years, second-year corn was rarely damaged by corn rootworms. The adult numbers are so high now, however, that even first-year corn should be checked for adults if the field is to be planted to corn for a second year.

The procedure to check for adults in August is: 1) go into the field beyond the margins and headlands, 2) and count the number of adult corn rootworms that you can see on 160 plants. The adults are usually most numerous on the silks, tassels and bases of the leaves and ears. Count only the adults that you can see on the plants without stripping back leaves or husks. The key number is 130 adults per 160 plants. If there are 130 or more adults per 160 plants, rotate that field to some other crop or treat with an insecticide (see Table 2) if corn is to be planted the following year.

Mature Corn

Check lodged, mature corn to see if the lodging was caused by corn rootworm. The goose-necked stalks (Figure 3) are characteristic of rootworm damage, but can also be caused by such things as cultivator injury or high wind with wet soil conditions. Check the roots and brace roots for tunneling



Figure 2. Roots on the right have been severely damaged by corn rootworm larvae; the roots on the left were protected from damage by an insecticide applied at planting time.

Table 1. Insecticides recommended for control of corn rootworm adults.^a

Insecticide	Formulation	Pounds active/acre	Limits ^b
Malathion	5.0 EC	1.0	5 days
Malathion	ULV Conc. ^c	4 liquid ounces	5 days
Diazinon	4.0 EC	0.5	0 days
Sevin	4.0 F, 50 WP, or 80 WP	1.5	0 days
Sevin	4.0 Oil ^c	1.0	0 days

^aApply by air or high clearance ground rigs. Do **not** apply insecticides when honey bees are working in the field.

^bMinimum days between application and harvest.

^cFor ultra-low-volume aerial applications only.

to be sure that rootworms were the cause. Rotate fields that show this injury or protect them from rootworms with an insecticide the following year.

CONTROL

Rotation

Rootworms are a pest where corn follows corn without rotation. The best way to control the root-



Figure 3. Lodging of corn caused by destruction of the roots by corn rootworm larvae. The stalks tilt right from soil level and often curve up (goose-neck) near their bases.

worm is to rotate the corn with another crop. Place infested fields in rotation unless there are real benefits from growing corn-after-corn in that particular field. The advantages of growing corn without rotation should be critically reviewed when pro-

Table 2. Insecticides recommended for control of corn rootworm larvae.

Insecticide	Formulation	Pounds active/acre	Limits ^b
<i>For use in 7-inch band at planting time</i>			
Dyfonate	4.0 EC, 10 G, or 20 G	1.0	
Lorsban	15 G	1.0	1 application per season; do not plant subsequent crops within 1 year of application.
Furadan	10 G or 4.0 F	0.75	
Mocap	10 G	1.0	Do not allow <i>Mocap</i> to contact seed
Thimet	15 G	1.0	
Counter	15 G	1.0	Do not plant crops other than corn or soybeans within 365 days after application; cover crops may be planted earlier if they are plowed down.
Dasanit	15 G	1.0	
Diazinon	4.0 EC or 14 G	1.5	

For use in 7-inch bands at post-emergence

Dyfonate	4.0 EC, 10 G, or 20 G	1.0	45 days to harvest
Furadan	4.0 F, or 10 G	0.75	
Mocap	10 G	1.0	
Thimet	15 G	1.0	Do not make later application
Dasanit	15 G	1.0	40 days to harvest; 1 application per season.
Diazinon	4.0 EC or 14 G	1.0	Apply no later than July 1

^aThe amounts given as band applications are for corn grown in 40-inch rows. Adjust this amount when other row widths are used by the equation:

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

where A is the pounds active insecticide per acre given in the table and W is the row width, in inches, that will be used. For example, if a 32 inch row width is to be used with an insecticide listed at 1 lb. per acre in the table:

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

^bBe sure to cover the insecticide with soil immediately after application.

blems develop with the corn rootworms. The alternative to rotation is a soil insecticide costing from about \$6 to \$8 or more per acre.

Adult Control

A spray of an insecticide is currently recommended only to protect grain set from the feeding of adults. When there are four or more adults per ear and pollination has not taken place, make an aerial application or ground application, using a high clearance rig of one of the insecticides cited in Table 1.

Larval Control

Corn can be protected from rootworm larvae by applying insecticide to the soil to kill the larvae **before** the damage is done. The application, therefore, needs to be made early in the season. We recommend that the insecticides (see Table 2) be applied in a 7-inch band centered over the row at planting time or shortly after emergence. Preplant, broadcast applications (covering the entire field with the insecticide before planting) and planting time in-furrow applications (applying the insecticide into a narrow band at planting) are **not** recommended because of cost and frequent failures. Apply the insecticide in a 7-inch band centered over the row.

Granules or sprays (when spray formulations are available) can be used. The amount of active insecticide applied per acre depends on the row width. The amounts in Table 2 are based on a standard 40-inch row and must be adjusted for other row widths. The adjustment is given at the bottom of Table 2. Remember, the amounts given are active insecticide and will need to be adjusted for the formulation used. The equipment will also need to be calibrated to deliver the exact amount needed. Adjusting from active insecticide to the formulation and instructions on calibrating equipment are given in Extension Bulletin E-1025 "Safe, Effective Use of Pesticides," available from your county Extension office.

Insecticides decompose rapidly when exposed to the sunlight and heat of the soil surface. Protect the

insecticide by covering with some soil as soon as possible. The press wheel may do this in planting time applications, but a ridged wheel, chains, a drag or some other means of covering the insecticide with soil is needed if the planter does not provide covering of the insecticide. The insecticide can be covered by a well-adjusted cultivator shoe or a rotary hoe in postemergence applications.

Some rootworm insecticides are labeled for application in mixture with herbicides or fertilizers. These are recommended **when they are compatible** with the fertilizer or herbicide that you are using and they can be applied in a 7-inch band and covered with soil. Read the label to be sure that the mixture will be effective before you try to use a mixture.

There is growing evidence that rootworm eggs begin to hatch very early in the spring. Rootworm larvae that hatch before corn is planted are lost from simple lack of food. Pesticides are also most effective when first applied and they break down with time. Late-planted corn will, therefore, have fewer larvae and reduced degradation of the insecticide than an early planted field. Heavily infested problem fields should be planted and the insecticide applied as late as is agronomically feasible.

Planting-time band applications—Place sprays or granules in a 7-inch band centered over the row at planting time. Place insecticide above, and out of contact with, the seed. You can do this by placing the insecticide fan or nozzle behind the seed spout on the planter. Be sure that the planter covers the seed with soil before the insecticide is dropped on the seed row.

Postemergence (or lay-by) applications—Apply a 7-inch band of insecticide to the bases of the growing plants. While many growers have found that the planting-time band application is most convenient, this postemergence application fits some farm operations. Postemergence application can be used to protect corn from the rootworms if they are not found until after the plants emerge. Make post-emergence applications during June when the plants are still small and before too many roots have been damaged by the worms.