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COVER PHOTO: Northern corn rootworm adult (upper left) and western corn rootworm adult (lower right). Photo by Larry Farlow.

Corn Rootworm Pest Management in Canning Sweet Corn

W. H. Luckmann, J. T. Shaw, D. E. Kuhlman,
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THREE SPECIES of rootworms — the northern, southern, and western corn rootworms — attack sweet corn in Illinois.

The southern corn rootworm, *Diabrotica undecimpunctata howardi*, also called the spotted cucumber beetle, is widely distributed and some individuals will be found in every cornfield in Illinois. It overwinters in the adult stage, oviposits in the spring and summer, and has several generations per year. Where southern corn rootworms are abundant, severe damage can occur in late-planted sweet corn (sweet corn coming into silk about September 1). However, this insect usually is not a serious problem and populations rarely reach damaging numbers in the canning areas of central and northern Illinois (latitude 40–42° N). Thus, these guidelines on pest management concern only the northern and the western corn rootworms.

The northern corn rootworm, *Diabrotica longicornis*, is a very common insect in Illinois cornfields. Although it is distributed throughout Illinois, damaging populations rarely occur south of U.S. Route 50 (latitude 39° N). The western corn rootworm, *Diabrotica virgifera*, invaded the northwestern corner of Illinois in 1964 and is now present throughout the northern two-thirds of the state. The western corn rootworm is a product of modern agriculture. It became a serious problem in irrigated corn in western Nebraska about 30–40 years ago. It developed resistance to the cyclodiene soil insecticides in the 1950's and the resistant strain began to migrate and disperse. Up to 1955, the western corn rootworm was found only in Nebraska and portions of Colorado, Kansas, South Dakota, and Iowa (Chiang 1973). Since then it has moved eastward, southward, and northward into all of the corn belt states. In time, the western corn rootworm will probably disperse to occupy the same range as the northern corn rootworm.

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BIOLOGY AND BEHAVIOR

In biological characteristics the northern corn rootworm (NCR) and the western corn rootworm (WCR) are quite similar. In the agroecosystem, corn is the only host, though it has been shown experimentally that the immatures of both species can develop on several species of native grasses (Branson & Ortman 1966, 1967*a*, 1967*b*). Adults feed on pollen, silks, and kernels of corn and on the fruiting parts of many other plants, including weeds.

The NCR and WCR have only one generation per year. Egg laying begins in late July and continues into September in the soil in fields of corn, with intensive oviposition occurring in August and early September. In general, the eggs are concentrated in the rows at the base of the corn plants in nonirrigated fields and between rows in fields with irrigation. The NCR prefers to oviposit at the base of the corn plants in the plant row and most eggs are deposited in the upper 4 inches of soil. Ovipositional behavior of the WCR is slightly different as females oviposit many of their eggs between the plant rows and eggs are often deposited at a greater depth in the soil. Following oviposition, eggs develop slightly and diapause through fall and winter. The eggs do not begin to develop again until spring. In Illinois the eggs begin to hatch in June and first adults appear about mid-July. A few eggs may not have hatched by the time first adults appear, but the egg stage normally lasts about 10 months.

The larvae feed on corn roots and concentrate near the base of the plant. The larvae consume the roots, thus decreasing nutrition supplied to the ears, and in strong wind and rain storms plants with severe root damage may become lodged. The larval plus pupal stages last about 1 month. In cages in the laboratory, adult rootworm females will live up to 2 months and oviposit for 3–4 weeks, during which time they will deposit about 400 eggs (range 300–1,000 eggs). In the field, adult life probably does not exceed 5–6 weeks. There is a preoviposition period of 2–2½ weeks. Fig. 1 illustrates the life cycle of the NCR and WCR and the period of time each growth stage can be found in Illinois. The ovipositional curve shows when intensive egg laying is occurring in cornfields.

The adults may remain for a considerable time in the field where they emerge. Later they disperse, seeking pollen in late-maturing corn, alfalfa, weeds, and ornamental plants. NCR adults congregate on silks and in tips of corn ears, whereas WCR adults have less tendency to congregate and they will be found on other parts of the plant as well

Fig. 1.— Life cycle of the northern and western corn rootworms in Illinois.

as the ears. WCR adults readily feed on corn leaves. Thus, counts made in ear tips will show a predominance of NCR adults, whereas visual counts on the entire plant may show a predominance of WCR adults. As the NCR and the WCR live together and have similar habits, there is some interaction between the two species. Several researchers have reported a displacement of NCR by the WCR (Hill 1967, Ortman & Fitzgerald 1964). Interspecific matings have been observed in the field and F_1 progeny of crosses were produced in the laboratory (Hintz & George 1965, 1967). The F_1 adults have the phenotype of the WCR.

Larvae of the NCR and the WCR are resistant to the cyclodiene insecticides over much of their range. Organophosphate and carbamate soil insecticides applied at planting time are used for control. Rotating corn with other crops is a means of control. Usually, only the larvae cause economic damage, but adults congregating and feeding on fresh silking ears can interfere with pollination, and in these instances insecticides are applied for adult control.

FIELD RECORDS

Detailed field observations were made in blocks of canning corn in major sweet corn production areas in Illinois in 1973 and 1974 (Boone, Ogle, and Vermilion counties). In the field study, select fields were divided into three groups, namely early-planted fields that were

harvested before August 8, midseason fields that were harvested by August 20, and late plantings that were harvested after August 20. Each of the fields in each group was examined numerous times during July, August, and September. Counts were made of numbers of adult rootworms in sweet corn fields during the 2–3 weeks before harvest. Further, soil samples were taken and the numbers of rootworm eggs were recorded at the time the fields were harvested, and again about October 1. Results of the postharvest examinations did not differ significantly from the observations made at the time of harvest, indicating that while adult rootworms inhabit fields of standing corn they do not readily invade or oviposit in areas where the standing corn plants have been removed. The results are summarized in Table 1. Interpreting these field observations along with published data already available allows us to draw certain conclusions:

1. Fields of sweet corn harvested before August 8 will attract few ovipositing corn rootworm adults, since the fields are harvested before initiation of intensive oviposition.
2. Fields of sweet corn are not attractive for rootworm oviposition after they have been mechanically harvested (no standing stalks in the field following harvest).
3. Aerial or ground sprays of carbaryl insecticide applied for con-

TABLE 1. — Summary of observations on the density of northern and western corn rootworm adults and eggs in early, midseason, and late plantings of canning sweet corn in Vermilion, Ogle, and Boone counties, Illinois, in 1973 and 1974.

Crop Characteristics	Density of Adult Rootworms Prior to Harvest	Rootworm Eggs Per Pint of Soil in the Fall, Sept. 15–Oct. 1
Early planted, silking in July, mechanically harvested by August 8	an occasional adult	0–1
Midseason planted, silking in late July and early August, mechanically harvested by August 20	0.1–1.0 per plant	0–5
Late planted, silking in August, European corn borer and corn earworm control program, mechanically harvested late August or September	an occasional adult	0–1

trol of the European corn borer (ECB) and the corn earworm (CEW) are very toxic to adult rootworms, and ovipositing adults are eliminated from sprayed fields once the spray program is begun.

4. Sweet corn fields that are harvested about mid-August (August 8–20) may contain some eggs since intensive rootworm oviposition is occurring, and these fields are usually not protected by sprays or dusts applied for ECB or CEW attacking the stalk and ear.

5. Since corn rootworm eggs are oviposited in one season and remain in the field until the next season, it is possible to plant sweet corn in fields that are virtually devoid of rootworm eggs due to early harvesting or spraying of sweet corn the previous year. Thus there is little or no need for soil insecticides for rootworm control on sweet corn when pest-management guidelines are followed.

THE MANAGEMENT PROGRAM

Annual planting of sweet corn in fields that were planted to sweet corn the previous year is the key to the rootworm pest-management program for canning corn. You can avoid corn rootworm problems by carefully designing your planting schedule in relation to harvesting dates of the previous season. However, the planting guidelines that follow apply only to sweet corn following sweet corn where the crop was mechanically harvested the previous year, or, if the crop was hand harvested, the standing stalks were mechanically destroyed immediately following harvest. The guidelines presented in this circular do not apply when sweet corn is planted in fields that were in field corn the previous year.

Adult rootworm counts of less than one per plant are below the damage threshold. It will not be necessary to count adult rootworms in fields in Categories 1 and 4 of the following section. Normally there would be no Category 3 fields, since sweet corn producers regularly treat to control ECB and CEW. You may wish to count adults in Category 2 fields, and the color photo on the cover of this circular will aid in easy recognition of the adults. Count adults on 25–50 plants to provide a representative sampling of the field regardless of size. The count should be made in early morning or early evening anytime during the 10 days preceding harvest. Some adults will be visible on the leaves and behind leaf sheaths but many will be in the silks and ear tips. A good method of counting is to grasp the ear tip and silk in one hand, cut off 1 inch of the ear tip with a knife and place it and silks into a plastic bag. Keep the bag tightly closed to prevent escape of the

adults. Put the bag containing the 25–50 ear tips and silks into a freezer to kill the adults. Then the contents can be easily examined and a record made of numbers of adult rootworms per plant.

Occasionally adult rootworms will become so abundant that they interfere with pollination of the ear. When this occurs, the adults can be suppressed with a single insecticide treatment applied to the foliage and ears with aerial or ground equipment.

The planting guidelines are given below and the potential for damage from corn rootworms is illustrated in Fig. 2. In some cropping seasons these calendar dates must be shifted slightly (2–4 days) to adjust for early or late crop and pest development.

CATEGORY 1. — Current year's planting is scheduled for sweet corn fields that were mechanically harvested before August 8 the previous year. Little to no rootworm oviposition occurred in these fields. Potential for larval damage during the current season is negligible. No rootworm soil insecticide is needed.

CATEGORY 2. — Current year's planting is scheduled for fields where the sweet corn crop was harvested after August 8 the previous year, and there was no spray program for ECB and CEW the previous year. Rootworm females oviposited eggs in these fields with potential for low to moderate damage. Use a soil insecticide at planting time to prevent damage by rootworm larvae if the adult rootworm count in the field was one adult or more per plant the previous year. Normally only a small acreage of sweet corn will be in Category 2, since a field enters Category 4 as soon as the first application of insecticide in the multiple treatment program has begun for ECB and CEW control.

CATEGORY 3. — Current year's planting is scheduled for fields where the sweet corn crop was harvested after August 20 the previous year and no ECB or CEW spray program was in effect. These fields were very attractive for oviposition by female rootworms in the previous year. Potential for damage by rootworm larvae is moderate to high. Use a rootworm soil insecticide at planting.

CATEGORY 4. — Current year's planting is scheduled for fields that received sprays for ECB and CEW the previous year. Carbaryl or a spray mixture containing carbaryl insecticide used for controlling these stalk and ear pests is very toxic to adult corn rootworms, and rootworm oviposition was suppressed or virtually eliminated. Potential for damage from rootworm larvae is negligible. No rootworm soil insecticide is needed.

Fig. 2. — Potential for damage from northern and western corn rootworm larvae in fields of canning sweet corn in relation to sweet corn harvest dates and pest control the previous year.

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