Kansas State University Agricultural Experiment Station and Cooperative Extension Service

KANSAS CROP PESTS

K-STATE Research and Extension

Corn Rootworm

Management in Kansas Field Corn

Description and Life Cycle

There are three corn rootworm species commonly found in Kansas: the southern, *Diabrotica undecimpunctata howardi* Barber; the northern, *Diabrotica barberi*; and the western, *Diabrotica virgifera virgifera* LeConte. The southern corn rootworm adult (Figure 1) is approximately ⅜ inch long with 12 black spots on a chartreuse background. The northern corn rootworm adult (Figure 2) is about ¼ inch long and pale green to yellow in color.

The western corn rootworm adult (Figure 3) is the same size or slightly larger than the northern corn rootworm. Their overall coloration is yellow with a black stripe on the margin of each wing cover, and they frequently have a dark stripe extending part way up the center of the wing covers. The southern corn rootworm is the most common adult rootworm found in Kansas. The western corn rootworm does the most damage to corn because of larval feeding on the roots.

Western and northern species have one generation a year, depositing eggs in the soil of corn fields from July through late September. Eggs overwinter and begin hatching in mid to late May. Larvae feed on corn roots (Figure 4) from late June until early July when pupation occurs. Mature rootworm larvae (Figure 5) are about ½ inch long and white and slender with brown heads and a brown plate on the top of the terminal segment. After pupating, adults emerge and begin to feed, mate, and deposit eggs.

Damage

Northern and western rootworm larvae tunnel into corn roots, pruning as they feed (Figures 6 and 7). Damage limits its uptake of soil nutrients and greatly reduces stress tolerance. Under favorable conditions, plants can regenerate roots with minimal yield loss, but under prolonged poor environmental conditions, losses can be severe. Significant rootworm feeding followed by strong winds can flatten (lodge) plants and reduce their ability to harvest sunlight. Corn typically rights itself, but some plants may be goose-

Figure 1. Southern corn rootworm

Figure 2. Northern corn rootworm

Figure 3. Western corn rootworm

Figure 4. Corn rootworm larvae feeding in corn root.

Figure 5. Corn rootworm larvae early instar (left) to mature instar (right)

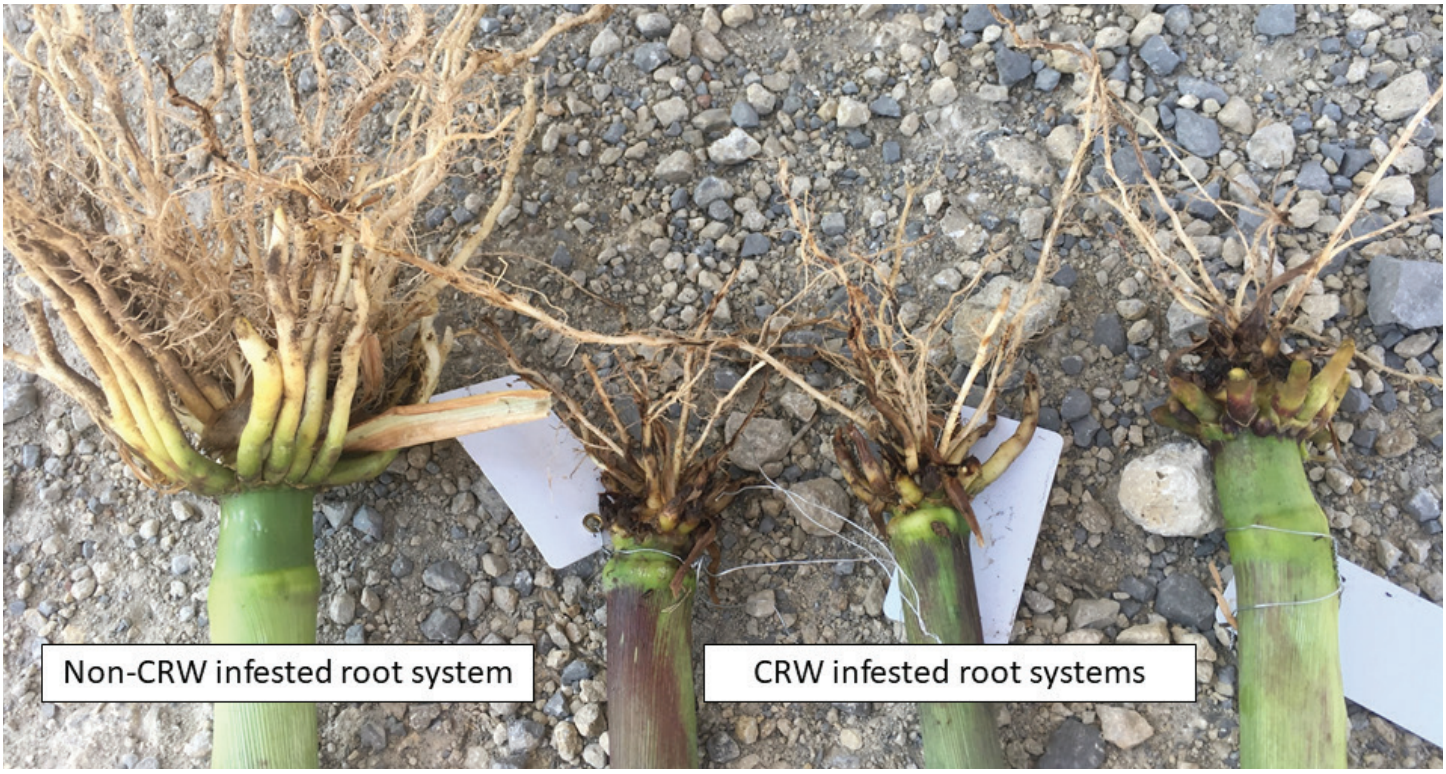

Figure 6. Healthy corn root (left) and CRW damaged roots (right).

necked. Lodging reduces yields and makes plants much more difficult to harvest. Yields may be reduced further if adult beetles clip silks before pollination.

Corn Rootworm Management

Rootworm insecticides or resistant hybrids are not recommended when corn is planted in rotation. Volunteer corn in non-corn fields should not extend rootworm larval problems into the following year unless plants persist throughout the mid-July through September egg-laying period at a density of more than 4,000 corn plants per acre. In some states in the upper Midwest, corn rootworms survive in a non-corn crop by remaining in the egg stage (diapausing) for two winters before hatching. This phenomenon has not yet been confirmed in Kansas.

Figure 7. Severe CRW larval feeding damage.

Rootworms are not as much of a problem in sandy soils or in southeast Kansas south of U.S. Hwy 54. Adult beetle counts should be taken in late summer to establish potential for economic damage and determine management practices for the next growing season. Although limited research indicates that more eggs may be deposited under reduced tillage or no tillage, increased egg deposition does not appear to increase crop damage. Sampling methods for predicting rootworm problems are discussed on page 4.

Planting-Time Options

Rootworms are more likely to be a problem in fields where corn is planted continuously for three or more years. Planting-time options for controlling corn rootworm larvae include planting resistant corn hybrids, using seed treatments, and applying soil insecticides at planting.

Some corn hybrids have been genetically engineered to resist corn rootworm larval feeding. Varieties with multiple resistance genes are priced incrementally higher based on the number of pests they control. Significant pressure from multiple pests may justify the cost. Corn rootworm resistance has been documented in corn that has been genetically modified to control rootworms, raising concerns about continued success of this control method. To delay resistance, growers are advised to rotate hybrids with different genetic mechanisms.

Seed treatments can be used to manage larval feeding but may have to be applied at higher rates to achieve the same level of control as soil insecticides, especially under signifi-

cant larval pressure. In some cases, it may be necessary to apply soil insectides at planting. Granular materials offer more consistent control of rootworm larvae in Kansas. Placement varies depending on the product. Granules are usually placed in a 6-to 8-inch wide band over a closed seed furrow. A mechanical device should be used to guarantee seed slot closure before placing certain insecticides on the ground. For a list of labeled products, see Corn Insect Management (MF810). Always read and follow instructions on the pesticide label.

Most soil insecticides work reasonably well as long as harsh environmental conditions do not persist. Very dry or wet conditions after planting can cause too little or too much movement of the product in certain soils. Other factors that affect control include:

- Planting extremely late the previous year, attracting more egg-laying beetles
- Inadequate calibration or poor application techniques
- A very mild winter, aiding egg survival
- Early planting (before April 18), which gives planting-time or seed treatments time to degrade or leach out of the area before rootworm eggs hatch
- Rootworms developing resistance to a product

Cultivation-Time Treatments

Most labels that allow application with cultivation, specify the need to apply insecticide before rootworm damage becomes severe. This is typically mid-May through mid-June, preferably before the third larval, and most damaging, stage. Adequate soil moisture is needed to move products throughout the rootworm feeding zone. Cultivation promotes root development from lower stalk nodes that come in contact with the soil, helping plants to recover from severe injury. When planting-time treatments have not been used, the threshold warranting cultivation treatments varies from 3 to 10 larvae per plant. This depends greatly on care taken in locating the tiny larvae. Several studies have shown that with adequate moisture and proper timing, root protection provided by cultivation-time treatments are equivalent or superior to treatments applied at planting. Reasons for not using cultivation-time treatments include:

- Very dry soils, which limit product movement into the root zone
- Very wet soils that prevent field access
- Concern that timely cultivation and insecticide application may not be possible
- Lack of access to bar-mounted granular applicator
- Utilization of no-till practices

Evaluation of Efficacy

Yield alone is not adequate to determine product performance because there are many other factors that affect yield after rootworms finish feeding. Leave an untreated control area two to four rows wide and 20-40 feet long at three or more locations in the field to determine the need for a rootworm insecticide. Look at roots removed from the untreated areas and compare them to roots from the treated areas to evaluate product performance. Mark untreated control areas at planting, so they can be located during the vegetative stage. Dig up, wash and evaluate root masses after peak damage occurs but before roots have regenerated enough to mask injury. This is typically in late June to early July.

To assess product performance, select a representative sample of five or more plants from several treated and untreated control areas. Cut the plant stalk about 12 inches above ground level, leaving a handle to move the root ball around. Sample root tissue, taking a 7-inch cube or as much as possible. Be sure to keep treated and untreated roots separate.

Place root balls in a washtub, garbage can, or another container filled with water. Soak, softening the soil until a high-pressure water stream easily washes roots clean. Evaluate roots immediately using the Iowa State University 1–6 Scale (Table 1) or the Node-Injury Scale (Table 2) on page 4. Do not confuse rootworm injury with cultivation damage or nematode injury, which occurs in areas of southwest Kansas. Learn about node injury and the Interactive Node-Injury Scale by visiting https://www.ent.iastate.edu/pest/rootworm/nodeinjury/nodeinjury.html.

On the 1-6 scale, a rating of 3 or more indicates the potential for economic losses due to larval rootworm feeding.

Table 1. Iowa State University 1 to 6 Scale

Rating	Description
1	No damage to only a few feeding scars
2	Feeding scars but no roots eaten within 1.5 inches of stalk
3	Less than one node of roots eaten and not within 1.5 inches of stalk
4	One node (or equivalent) eaten within 1.5 inches of stalk
5	Two nodes (or equivalent) eaten within 1.5 inches of stalk
6	Three nodes (or equivalent) eaten within 1.5 inches of stalk

For node-injury ratings between 1.25 and 1.75, economic losses can be expected when plants are under heat, water, or disease stress. Economic losses are likely if average ratings are above 1.75.

Table 2. Iowa State University Node Injury Scale

Rating	Description
0	No damage
1	One node (or equivalent) eaten to within 1.5 inches of stalk
2	Two nodes (or equivalent) eaten to within 1.5 inches of stalk
3	Three nodes (or equivalent) eaten to within 1.5 inches of stalk

Damage between complete nodes eaten are noted as percentage of node missing, i.e. 1.75 = 1 ¾ nodes eaten.

Silk Clipping Prevention

In rare instances, early feeding (clipping) of corn silks by adult beetles may disrupt pollination. Silk clipping that occurs after pollination does not affect yield. Foliar spray treatments may be justified when there are 8-10 beetles per ear and 10 percent of the silks are just beginning to show. In corn fields stressed by other factors, as few as five beetles per ear may result in economic losses.

Predicting Rootworm Problems

In continuous corn fields, counts of adult northern and western corn rootworms can be used to determine whether management will be necessary the following spring. Fields should be scouted at least once a week from 1 July through August, and sometimes into September.

To sample, grasp the ear tip with the palm to prevent beetles from escaping while the plant is examined. Then open your hand and count the beetles as they leave. Look for beetles hiding where the leaf joins the stalk. This sampling technique works best in the morning, until temperatures reach about 90 °F. An average of 5 beetles per 10 plants, taken from at least four random locations throughout the field indicates the need for management the following season if the field is planted back to corn.

An unbiased method for sampling continuous corn fields for adults involves the use of Trécé Pherocon® AM traps (yellow sticky traps). Place traps on each side of the cornfield, at least 10 rows or 50 feet into the field, attaching traps to plants at ear height. Switch traps or count adult western and northern rootworm adults weekly. If traps average 25 beetles per week per trap or 15 beetles per trap for two consecutive weeks, management is warranted if corn is planted in the field the following season.

Soil Insecticide Alternatives

Adult control can be used to suppress egg laying, which results in economic damage by larvae the following summer. This method is only recommended for those willing to scout fields weekly and should be implemented area-wide to maximize benefits.

Figure 9. Gravid female

Scout fields weekly from the time beetles first emerge until they stop laying eggs (July–September). If beetle counts reach the 0.5/ear zone (5 beetles/10 plants) and 10 percent of the female rootworms are swollen with eggs (gravid) (Figure 9), make a spray application immediately. The ear zone includes the area bracketed by the lower surface of the leaf above the ear, down to and including the upper surface of the ear leaf below the ear. Counts should only include northern and western corn rootworms.

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Photos by the authors except for northern corn rootworm, *Insects in Kansas*, Third Edition, Glenn Salsbury and Stephan White, and gravid female corn rootworm, Phil Sloderbeck.

Publications from Kansas State University are available at *www.bookstore.ksre.ksu.edu*

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