

Insect Pests

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To manage insect pests of corn, producers have a large number of effective options including preventive cultural controls (such as rotation), insecticides, and resistant hybrids from natural and biotech sources. The challenge for producers is to select only the insect management tools that are needed to prevent economic losses. Producers use crop growth information, pest intensity levels and development stage, pest history, weather conditions, grain price, expected yield, and cost of the control to determine the need for action.

Insect Resistance through Biotechnology

Agricultural biotechnology is producing highly effective tools to manage troublesome corn insect pests. These hybrids use various genes from the soil bacterium *Bacillus thuringiensis* (Bt) to produce proteins that disrupt the digestive system of certain insect pests. These Bt proteins are very selective, i.e., each one will affect only specific groups of insects. These proteins are nontoxic to mammals and other animals. Biotech hybrids are available that control European and southwestern corn borer and suppress fall armyworm and black cutworm. In the near future, other types may be available that provide control of corn rootworm and enhanced control of black cutworm.

In the case of Bt corn, to kill a susceptible insect, a part of the plant that contains the Bt protein (not all parts of the plant necessarily contain the protein in equal concentrations) must be ingested. Within minutes, the protein binds to the gut wall and the insect stops feeding. Within hours, the gut wall breaks down and normal gut bacteria invade the body cavity. The insect dies of septicaemia as bacteria multiply in its body. Even among

Lepidoptera larvae, species differ in sensitivity to the Bt protein.

Producers using pest-resistant biotech crops must use recommended resistance management strategies because pests may have a high potential to develop tolerance to crops containing Bt. It is the producer's responsibility to use approved resistance management practices when using biotech crops.

Pest Monitoring Procedures

To monitor for insect pests in corn, random sites are selected in the interior of fields. Scouting methods will differ among the key pests. The number of sites depends on the size of the field. In fields of fewer than 25 acres, three sites are needed. In larger fields, add one site for each additional 10 acres. Use recommended scouting methods for specific pests so that scouting information can be compared with the established treatment guidelines.

Key Factors

Planting date and spring weather conditions to a large part determine the potential for insect damage to corn. Southwestern corn borer, European corn borer, fall armyworm, and corn earworm are generally more damaging to late-planted corn. Typically, corn planted after May 10 in Western Kentucky and after May 20 in Central Kentucky is at greater risk to sustain economic losses from these pests. Very early planted corn may experience greater first generation European corn borer activity but will usually escape damage by the second generation. Cool weather conditions and low soil temperatures after seedling emergence may expose young plants to cutworm and flea beetle

damage over an extended period. Greater attention should be paid to monitoring plants for seedling pests during these growing conditions.

Major Pests

Black Cutworm

Cutworms are potentially very destructive but are unpredictable, and the chances of significant damage in any given year are relatively low. Corn can be seriously damaged by cutworms from planting through mid-June while the plants are less than 18 inches tall. Serious losses are often associated with wet springs that have caused a delay in planting or during periods of cool weather. Cutworms feed mostly at night and hide during the day under clods of soil or in burrows below the soil surface. They cut off the seedlings at or just below the soil surface. The potential for cutworm infestations is influenced by late planting, low and wet areas of the field that drain poorly, and fall and early season weed growth. Preventive treatments made at planting may or may not provide sufficient control. A rescue treatment may be necessary for moderate to heavy in-



Black cutworm.

festations even when a preventive treatment was used. Early land preparation and weed control help to reduce cutworm problems because infestations usually develop on early season weed growth. Control weeds at least 2 weeks before planting.

Scouting Procedures

Description: Cutworms vary from dark greasy-gray to black. They have a lighter colored stripe down the middle of the back, smooth skin, and a brown head capsule. Cutworms may reach 1³/₄ inches in length. Cutworms commonly coil up into a “C” shape when disturbed.

Damage: Small larvae chew small holes in leaves; large larvae chew into the base of seedlings, cut small plants, and may pull plant parts into the burrow. Symptoms are wilted or cut plants.

When to monitor: Corn should be monitored for cutworms at least twice a week for the first 3 to 4 weeks after seedling emergence.

How to scout: Begin making counts when wilted or cut plants are first observed. Examine 20 consecutive plants and record the number of cutworm-damaged plants. Look for live cutworms near damaged plants as they hide during the day. Dip up an area 3 inches in radius around the base of a

damaged plant. Note the number and size of cutworms.

Economic threshold: 3 percent or more cut plants and 2 or more live larvae, 1 inch or smaller, per 100 plants. If conditions are borderline, check field again in 24 to 48 hours.

Corn Flea Beetle

Flea beetles are among the first insects to feed on emerging corn. These beetles overwinter as adults near corn fields and are active in weeds early in the spring. Populations are generally highest following mild winters. These very small, dark insects jump readily when disturbed; hence the name flea beetles. Flea beetles are important in corn for two reasons. First, they are leaf feeders and large infestations can kill small seedlings. Feeding by these beetles results in scarring of the leaf surface that appears from a distance as frost injury. Serious damage can occur on plants less than 6 inches tall. Most hybrids will recover from moderate levels of flea beetle damage under good growing conditions. Control is rarely justified, unless damage is extensive and growing conditions are poor. Early feeding often occurs during cool weather when corn growth is retarded. Second, flea beetles are also vectors of Stewart’s wilt, also known as bacterial leaf blight. Selec-

tion of corn varieties resistant to this disease should be considered.

Scouting Procedures

Description: Corn flea beetles are very small, dark insects that jump readily when disturbed.

Damage: These beetles are leaf feeders. They make small feeding scars on the surface giving leaves a gray, frosted appearance. Damage is generally serious on plants less than 6 inches tall. Flea beetles transmit Stewart’s wilt, also known as bacterial leaf blight.

When to monitor: Check corn from emergence until 12 inches tall. Flea beetle stress may be great on late-planted corn. However, early-planted fields may also show noticeable damage.

Economic threshold: Treat only when 50 percent or more of the plants show signs of feeding on new leaves with some leaves turning white or brown.

Corn Rootworms

Corn rootworms can be serious pests of continuous corn in Kentucky. The typical damage symptom is lodging or “goose-necking” of corn that may begin to appear near the end of the larval feeding period. The entire root system may be destroyed by a



Corn flea beetle.



Western corn rootworm larva.

heavy population pressure. Pruned roots place physiological stress on the plant by reducing water and nutrient uptake that reduces yields, especially when coupled with low moisture or poor fertility. Emerging corn rootworm beetles feed on green silks, pollen, and green epidermal layer of corn leaves. While rootworm adults may be found in soybean, alfalfa, or sorghum late in the growing season, unlike in states farther north, damage by rootworm larvae to corn following these crops is rare in Kentucky. Crop rotation continues to be the most effective method of controlling rootworm larval damage. Because most rootworm eggs are laid in corn fields during the growing season, if corn is not planted in the field the following year, the hatching larvae are left without food and will starve. Treatment of first-year corn for rootworm is not normally needed in Kentucky.

Scouting Procedures

Description: Corn rootworm larvae have cylindrical white to cream bodies with a brown to black head and a pair of small legs on each of the first three segments behind the head. There is a small brown or black area on the top of the last segment. Full grown larvae are about 1/2 inch long. Three species of corn rootworm beetles are found in Kentucky. The northern corn rootworm adult is pale green to yellow and about 1/4 inch long. The southern corn rootworm adult (also called the spotted cucumber beetle) is about 3/8 inch long. It is yellow-green with 11 conspicuous black spots on the wing covers. The western corn rootworm beetle is yellow with three black stripes on the wing covers.

Damage: Larvae feed on corn roots reducing the uptake of water and nutrients. High winds may blow down severely damaged plants. Adult beetles feed on silks, pollen, and leaves. Large numbers during pollen shed may clip silks and interfere with pollination. Adult rootworm feeding

on leaves generally does not affect yield.

When to monitor: Monitor for rootworm symptoms from late May through June. Watch for irregular growth patterns and plant stress. Monitor for adult rootworms from onset of silking until silks are brown. Also late-planted corn should be inspected in the whorl stage for adult beetles.

How to scout: Dig up a 6-inch cube of soil containing the root zone of stressed plants to scout for larvae and their damage. Carefully break away the soil from around the root zone and look for rootworm larvae and evidence of chewing on the plant roots. To monitor for adults, look for beetles as you walk through the field. If beetles are active, follow these guidelines: 1) Make counts on 20 plants from each location beginning with random selection of the initial plant. Make counts on every third or fourth plant until 20 plants per location are examined. 2) Rootworm beetles fly readily when disturbed so approach each plant carefully. Count the beetles on the ear tip, tassel, leaf surfaces, and behind the leaf axil.

Economic threshold: There are no effective rescue treatments once symptoms of rootworm damage begin to appear. Damage by rootworm larvae indicates the need to rotate to another crop next year or to use a soil insecticide at planting if planting corn in that field next year. Treatment may be necessary to control adult rootworms if silks are clipped back to 1/2 inch or less before 50 percent of plants are pollinated and five or more beetles are present per plant. Counts of northern and western corn rootworm beetles are used to make soil insecticide recommendations for the following year. If counts of western or northern or both together approach or reach an average of 20 beetles per 20 plants (1 per plant), the farmer will be advised to use a rootworm insecticide if corn is grown in this field next year.

Armyworm

Armyworm is a sporadic early season pest that can cause occasional losses in corn and should be monitored in the spring. Infestations usually first develop in fields of small grains or in other grass cover crops. In conventional tillage systems, partially grown larvae can migrate into corn fields from grass waterways or wheat fields. Damage is usually first noticeable around the field margins adjacent to these areas. Armyworms usually feed at night and damage corn by chewing leaves. They prefer to feed on the succulent leaves in the whorl first. Feeding is usually confined to leaf margins, but occasionally the insects may strip the entire plant, leaving only the midrib of the leaves. During the day, armyworms are found in the soil or underneath groundcover.

Scouting Procedures

Description: The full-grown 1 1/2 inch armyworm has a greenish brown body with a thin stripe down the center and two orange stripes along each side. The head is brown with dark honeycombed markings.

Damage: Armyworms usually feed at night and damage corn by chewing leaves. They prefer to feed on the succulent leaves in the whorl first. Feeding is usually confined to leaf margins, but occasionally they may strip the entire plant, leaving only the midrib of the leaves.

When to monitor: Mid-May through June. Armyworm damage is often associated with cool, wet spring weather conditions.

How to scout: In conventional tillage, infestations usually begin around the field margins adjacent to small grains or grassy strips. These areas should be scouted first. If armyworms are present, determine how far the infestation extends into the field. To sample for armyworms, examine 20 consecutive plants in each of at least five random locations in the field. Note the number of plants with the characteristic damage and the size of



Armyworm moth.



Armyworm.

the larvae. When scouting for armyworms, look on the armyworms for parasitic eggs. These small, oval, yellowish eggs are usually located just behind the head of the larva. These are eggs of a fly parasite that will kill the larva.

Economic threshold: Control actions in corn are recommended when armyworms average between $\frac{1}{2}$ and $\frac{3}{4}$ inches and the entire field averages 35 percent infested plants or 50 percent or more defoliation is seen on damaged plants. Do not include parasitized larvae in the counts used to determine the economic threshold.

European Corn Borer

The corn borer larva tunnels into corn stalks and ear shanks and feeds on kernels in the ear. The severity of corn borer infestations varies from year to year and even from field to field on the same farm. First-generation moths are attracted to early-planted corn, while late-planted corn is most susceptible to damage from the second generation. Corn borers cause damage in two major ways. First, tunneling in the stalk reduces water and nutrient flow and contributes to physiological yield loss. This is the primary cause of yield reduction. Second, borers produce cavities in the plant that weaken it. Stalk breakage and ear drop, prior to harvest, can lower yields through harvest losses. These losses increase if harvest is delayed. Strong winds or driving rains during early season moth flight may reduce corn borer activity for the entire season. However, calm, warm nights during the egg-laying promotes high corn borer populations, even if the adult population is relatively small. Early harvest can reduce losses due to broken or lodged plants or dropped ears. Second-generation damage is the primary cause of harvest loss. Early planting combined with early harvest can be an effective management strategy.

Scouting Procedures

Description: Eggs are creamy white when first laid and develop a dark spot close to hatch. Eggs are laid in groups of 15 to 35 and overlap each other much like fish scales. Larvae are pinkish colored, marked with small round brown spots and a faint grey stripe running the length of the back. They reach 1 inch when fully grown.

Damage: Small first-generation larvae make “window pane” holes in leaves that are noticed as they emerge from the whorl. Some enter leaf midribs and cause them to break. Larger larvae tunnel into the stalk. Second-generation damage include feeding on the stalks, tassels, ear shanks, and developing kernels.



European corn borer.



European corn borer moth.

When to monitor: First generation: Late May to early June. Early-planted corn has the greatest potential for damage. Second generation: Late June to August. Late-planted corn is most susceptible to this generation.

How to scout: Randomly select 20 consecutive plants at each site. For the first generation note the number of plants with fresh damage to leaves emerging from the whorl. Pull the whorls from two damaged plants and examine for the presence of borers. For the second generation, pay special attention to late-planted fields. Examine 20 plants per locations and check plants for egg masses and signs of feeding and larvae feeding on the leaves, tassels, leaf axils, or behind leaf sheaths.

Economic threshold: Treat for first generation if 50 percent or more of the plants are infested and live larvae are present in the whorls. For the second generation, treatment is recommended if an average of one egg mass per plant is recorded or if 50 percent of the plants have live larvae feeding on the leaves, tassels, leaf axils, or behind leaf sheaths. A more comprehensive economic threshold can be found in *European Corn Borers in Corn* (ENT-49).



Southwestern cornborer.



Southwestern corn borer moth.

Comments: All of the currently available Bt-corn hybrids provide effective control of first-generation larvae, but some do not maintain this level of control against the late-summer generations.

Southwestern Corn Borer

While similar in biology to the European corn borer, southwestern corn borer is more difficult to control. It is found in the western part of the state and has two generations per year. The first generation attacks whorl-stage corn and is associated with losses to yield by stunting or killing plants. The second generation occurs during mid- to late summer and increases harvest losses through stalk breakage due to extensive tunneling. In the fall, overwintering larvae increase plant lodging by girdling the base of the stalk just above the soil. Early planting, when practical, is generally the most efficient and economical method of preventing plant damage and yield losses to this pest. However, wet weather frequently delays corn planting and increases the possibility of borer infestations. Corn planted after May 1 has a greater potential for southwestern corn borer infestations. Lower establishment rate by second-generation borers on older plants is the primary reason for early planting.

Scouting Procedures

Description: Eggs are laid singly or in groups of two to five, with the flattened eggs overlapping like fish scales. Initially eggs are greenish-white but develop three distinct red transverse lines within 24 to 36 hours. Larvae are creamy-white with numerous conspicuous black spots and a brown head capsule. The full-grown larva is 1¼ inch in length.

Damage: For the first 2 weeks, first-generation larvae feed within the whorl of the plant; later they tunnel into the stalk. Numerous holes in the emerging leaves and leaf breakage due to midrib tunneling are characteristic. The second generation causes the greatest damage. These larvae begin feeding in the mid and lower zones of tassel-stage corn in mid-to-late July. After about two weeks, the larvae begin tunneling in the stalk. Characteristically, they make a straight line through the middle of the stalk. In the fall, borers that will remain larvae throughout the winter migrate to the base of the plant and girdle the plant at the base before tunneling downward. Larvae girdle the stalk by chewing a complete or partial internal groove, leaving only a thin outer layer for support.

When to monitor: First generation: Late May to the end of June. Early-planted corn has the greatest potential for damage. Second generation: Early July to the end of August. Late-planted corn is most susceptible to this generation.

How to scout: Use the same methods described for the European corn borer.

Economic threshold: Controls for first-generation southwestern corn borer should be considered if 35 percent of the plants show signs of damage and live larvae are present in the whorls. Control of second generation with insecticides is difficult because the attack is concentrated low on the stalk.

Comments: All of the currently available Bt-corn hybrids provide effective control of first-generation larvae, but some do not maintain this level of control against the late-summer generations. Currently, only the YieldGard hybrids provide the full-season control needed to prevent the stalk girdling caused by the late-season larvae.

Fall Armyworm

Fall armyworm can be one of the more difficult insect pests to control in field corn. Late-planted fields and



Western corn rootworm adult.



Fall armyworm.

late-maturing hybrids are more likely to become infested. Fall armyworm causes serious leaf feeding damage as well as direct injury to the ear. While fall armyworms can damage corn plants in nearly all stages of development, they will concentrate on late plantings that have not yet silked. Large fall armyworm larvae consume large amounts of leaf tissue, resulting in a ragged appearance to the leaves similar to grasshopper damage. Larger larvae are usually found deep in the whorl, often below a “plug” of yellowish brown frass. Beneath this plug, larvae are protected somewhat from insecticide applications. Plants may recover from whorl damage without any reduction in yield. Producers should pay close attention to late-planted fields; problems are usually associated with fields planted after June 1. Some Bt-corn hybrids may suppress this insect.

Scouting Procedures

Description: The spherical gray eggs are laid in clusters of 50 to 150, usually on the leaves. Egg masses are covered with a coating of moth scales or

fine bristles. Larvae hatch in three to five days and move to the whorl. Larvae range from light tan to black with three light yellow stripes down the back. There is a wider dark stripe and a wavy yellow-red blotched stripe on each side. Larvae have four pairs of fleshy abdominal prolegs in addition to the pair at the end of the body. Fall armyworm resembles both armyworm and corn earworm, but fall armyworm has a white inverted “Y” mark on the front of the dark head. Fall armyworm has four dark spots arranged in a square on top of the eighth abdominal segment.

Damage: Small larvae cause elongated “window pane” damage to leaves similar to European corn borer. The most common damage is to late pre-tassel corn. Large fall armyworm larvae consume large amounts of leaf tissue resulting in a ragged appearance similar to grasshopper damage. Large larvae are usually found deep in the whorl, often below a “plug” of yellowish brown frass. Beneath this plug, larvae are protected somewhat from insecticide applications. Plants often recover from whorl damage without

any reduction in yield. On later stages of corn, fall armyworm larvae often attack the developing ear directly.

When to monitor: Begin monitoring in mid-June. Pay close attention to late-planted fields or fields with a history of these problems.

How to monitor: Survey 20 consecutive plants from at least five locations in the field. Examine the plants for egg masses, signs of damage, and live larvae in the whorl. Pull the whorl on two damaged plants to determine if the larvae are protected beneath a frass plug.

Economic threshold: If present in damaging numbers in the field, it must be controlled while the larvae are still small. Control needs to be considered when egg masses are present on 5 percent of the plants or when 25 percent of the plants show damage symptoms and live larvae are still present. Controlling large larvae, typically after they are hidden under the frass plug, will be much more difficult. Treatments must be applied before larvae burrow deep into the whorl or enter ears of more mature plants.