STALK BORER ECOLOGY AND PEST MANAGEMENT OPTIONS IN CORN

Marlin E. Rice
Associate Professor
Extension Entomologist
Department of Entomology
Iowa State University

Craig Tordsen
Extension Associate
Tama County Extension Office
Iowa State University

Management of stalk borers in corn has always be a challenge for farmers but this year seemed to be especially troublesome. The insect is not considered to be a major pest, like corn rootworms or European corn borers, but this year was an exception. Corn rows adjacent to grass terraces, fence lines, waterways, or where grass control in the cornfield was poor the previous summer were often heavily infested.

Historical Perspective

The stalk borer is a native insect that ranges from the Atlantic Coast to the Rocky Mountains. The first recorded infestation in Iowa corn was near Keokuk in 1890. In 1926 and 1927, the stalk borer was unusually destructive in all parts of the state. There were many reports of serious damage; sometimes 80% of the stand was destroyed. It has been collected in every Iowa county and George Decker, an entomologist at Iowa State University more than 60 years ago, speculated that it could probably be found on every farm in the state (Decker 1931).

Recent Problems

In recent years, increases in conservation tillage, perennial grass populations, and the construction of more conservation terraces and waterways have favored the stalk borer and subsequent damage to corn (Levine et al. 1984; Lasack et al. 1987). More inquiries were received about stalk borers than any other insect during June of 1993. In western Iowa, farmers in Woodbury and Plymouth counties reported 75-100% of young corn plants infested. These fields were no-tilled and had problems with either foxtail or woolly cupgrass last year. Large, field-wide infestations are the result of moths laying their eggs in the grass during late summer. When corn is planted back into a grassy-weed situation, then the possibility exists for stalk borer problems. Herbicides sprayed to kill the grasses the following spring forces the larvae to move from the dead grass to corn. In conventional tilled or cultivated fields where grassy weeds are kept under control, then most stalk borer damage is confined to the first four rows adjacent to grass ditches, terraces, fence lines, and waterways.

Life Cycle

The life cycle begins when moths lay eggs during late summer. Over a four-year period (1980-1983), the peak flight of moths occurred during September 8-14 in Iowa. Occurrence of the first flight ranged from August 10-21 and the last flight was October 5-19 (Bailey et al. 1985). Moths are attracted mostly to leaves and stems of grasses and weeds to lay their eggs. Grass terraces, ditches, fence lines, grass waterways, and weed patches are preferred sites. The eggs hatch the following spring from late April to early May (Levine 1983). There is a single generation per year.

The larvae bore into the first suitable plant they find. If they grow too large for this stem, they will leave the plant and seek a different and larger diameter host to infest. They are rather indiscriminate feeders and have been collected from 176 plant species including green foxtail, quack grass, orchard grass, brome grass, blue grass, wirestem muhly, smartweed, lambsquarter, pigweed, alfalfa, sweet clover, dogbane, giant ragweed, cocklebur, golden rod, and yarrow (Decker 1931; Lasack and Pedigo 1986). Stalk borers commonly infest corn growing near fences, waterways, or terraces that contain these weeds or grasses.

The larvae are striking in appearance (at least for caterpillars). White and brownish-purple strips extend the length of the body and directly behind the true legs is a large purple spot on either side of the body. We call this the "purple heart" and it fades as the larvae grow older. The yellow head also has a black stripe along the side and this can be used to identify stalk borers from all other corn caterpillars.

Crop Injury to Corn

Larvae may attack corn anytime after it emerges. This year, fields with two-leaf corn were found with 1/4-inch larvae feeding inside the stalk on May 24. Larvae inside those plants moved there immediately after hatching and did not bore into grass first.

Larvae that attack corn can produce two kinds of injury; leaf feeding and stalk tunneling. Leaf feeding is probably the most commonly observed injury. Larvae crawl down inside the whorl and feed on the developing leaves. Feeding results in ragged holes that appear in the leaves as they unfold. Leaf feeding by larvae does not reduce grain yields (Bailey and Pedigo 1986). The other injury symptom is much more severe. This occurs when larvae tunnel through the plant and then destroy the growing point. This causes what is known as dead heart. The upper leaves are cut off within the heart of the plant and they wilt and die. The outer leaves remain green and apparently healthy. Plants with dead heart have barren rates of 25 to 63%. Plants that survive and grow tillers do not produce normal-sized ears. Yields are only about 30% of the grain compared with undamaged plants with tillers (Levine et al. 1984). A barren plant that survives is essentially a weed; it competes with neighboring plants for moisture, nutrients, light, and space, but produces no grain. Because of this competition, the uninfested adjacent plants do not compensation for the yield that is lost from the barren plant unless the infested plant dies (Bailey and Pedigo 1986). The physiological basis for the yield reductions in plants with dead heart is mostly because the plants silk later and do not catch sufficient pollen to pollinate all the kernels (Bailey and Pedigo 1986). Yield losses caused by stalk borers decline as the plant is attacked later in development. Once the plant begins to elongate (6-leaf stage), the ability of the plant to tolerate stalk borer injury greatly increases (Davis and Pedigo 1991b). Larvae also can tunnel into corn stalks below the growing point, but this does not kill the plant. We have seen up to four larvae per corn stalk in silking-stage corn.

In conventional-tilled fields without a grassy-weed problem, most of the damage occurs in the four rows next to permanent grassy areas. When the first or second corn rows are shorter than the inside rows, the cause of the problem is usually stalk borers. A common misconception is that those rows are stunted because of competition for moisture from the grass or weeds. An examination of the stalks, however, should reveal stalk borers inside the plants.

Crop Injury to Soybean

Injury to soybeans is a seldom-observed event and yield losses have not been reported. Prior to this year, I (MER) had only seen one field during the last five years that had stalk borers in soybeans. This field was in the R5 stage (developing pod) and only a few plants in the border rows were infested. On June 29 of this year, I scouted two fields in Carroll County that had a very large population of stalk borers in corn last year. What I found was that stalk borers had infested young plants in both fields, primarily in the outside row. Infested plants varied in age from the unifoliolate to three-trifoliolate stage and all had wilted terminals. The infestation was actually minor because only three percent of the border row plants showed evidence of attack (Rice 1993).

A review of the research conducted on stalk borers in the Midwest did not find this insect recorded as feeding in soybean. It would certainly be easy to overlook stalk borer injury. In a few days, neighboring plants that are not infested would outgrow and overshadow the infested plant. The plant would wilt, then die, and never be noticed.

The importance of these observations is that they substantiate the idea of scouting soybeans replanted into infested corn. When a corn field has 75-100% of the plants infested, is rotary hoed or disked, and replanted to soybeans, then the seedlings should be scouted shortly after emergence for evidence of stalk borer activity. Larvae can probably survive for several days in torn-up corn until the soybeans emerge. Long-term management will require grass control so that eggs are not laid across the field during late summer and the problem repeats itself next year.

Management Options

Biological and Environmental Controls. Heavy rainfall during the egg-hatching period probably plays a significant role in reducing stalk borer populations (Lasack et al. 1987). But once the small larvae (1-3 instars) tunnel into grass stems, they apparently are well protected from adverse climatic conditions as well as predators (Lasack et al. 1987). Later, populations decline significantly because of predation by ants, ground beetles, and spiders when the fourth, fifth, and sixth instars migrate in search of larger-diameter hosts. Mortality caused by parasites accounts for less than five percent (Lasack et al. 1987). All of these factors contribute to larval mortality but they can not be relied upon to prevent yield losses.

Chemical Control. Corn is infested when either newly-hatched larvae tunnel into young corn plants (such as in a no-till field), or when partially-grown larvae crawl from grass in search of larger-diameter plants (Davis and Pedigo 1990). Chemical control is difficult to obtain because larvae are exposed for very short periods of time and they can not be killed once they tunnel into the plant. An insecticide must be timed to coincide either with egg hatch or movement from grass to corn (Davis and Pedigo 1990).

One approach is to target the hatching larvae. Applications of permethrin (Ambush, Pounce) timed to coincide with hatch were effective in reducing stalk borer populations in terraces by 54-85%, which resulted in a 50-75% reduction in damaged corn plants (Davis and Pedigo 1990). Timing is critical and should occur between 575-750 oF degree days, using a base threshold of 41oF beginning January 1. The negative aspect of this approach, however, it that no consideration is given to the size of the stalk borer population. An insecticide could very well be applied in the absence of an economically-damaging population.

A second approach is to target an insecticide application, based on degree days, to coincide with migration of the larvae from the grass to the corn. Davis and Pedigo (1991a) predict that 10% and 50% of the larvae will move out of the grass by approximately 1,400oF and 1,700oF degree days, respectively. A calendar can not be used to predict this movement because of variations in the weather. Fifty percent movement can fluctuate by as much as two weeks, i.e. June 9 (1985) and June 25 (1984) (Lasack and Pedigo 1986).

Scouting of corn should begin about 1300-1400 degree days to verify that stalk borers are present in grass (look for dead stems and larvae inside) or they are moving into the field. Economic injury levels (Table 1) and can help in determining the need on an insecticide application. Any decision to apply an insecticide should be done between 1,400-1,700 degree days. The economic injury level for stalk borer depends on the corn-leaf stage and the percent of plants infested (Davis and Pedigo 1991a). Economic injury levels have been calculated for corn in the 1 to 7-leaf stages as a percent of injured plants in the first two rows under either adequate moisture or drought stress conditions.

Younger plants are more susceptible to yield losses from stalk borers so an insecticide application during the early phase of movement may be preferable (Davis and Pedigo 1991a). Stalk borers do not migrate very far from grassy areas, so only the first four corn rows next to terraces, fence lines, or waterways will need to be sprayed.

A third approach is necessary if a field-wide grass problem has contributed to stalk borer problems in past years. At-planting, in-furrow treatments of a granular insecticide (carbofuran) have not reduced the amount of dead heart (Bailey et al. 1985) or injured plants (Bowman and Everich 1985). Counter 15G banded over the whorl of young plants also is ineffective in preventing crop injury but rescue applications of a pyrethroid have had significantly fewer injured plants (Foster and Stockdale 1983b). Even pre-emergence treatments of a variety of pyrethroids have reduced the number of injured plants (Fletcher and Roberts 1987). The most effective approach is a burndown herbicide-insecticide combination, either tank mixed or a split application, as opposed to an insecticide used alone (Bailey 1984; Foster and Stockdale 1983a; Foster and Wintersteen 1984, 1985). The herbicide kills the grass, forcing the larvae out of the plant to search for another host. Insecticides can be tank mixed with fast-acting herbicides, or applied several days after a slow-acting herbicide. Ambush 2E (6.4 to 12.8 ounces per acre), Asana XL (5.8 to 9.6 ounces), Lorsban 4E (2 to 3 pints), or Pounce 3.2EC (4 to 8 ounces) are recommended for stalk borer control.

Cultural Control. Burning of grass and weeds in egg-laying sites is another possible method of reducing the damage. It was over 60 years ago that Decker (1931) reported that stalk borer populations could be dramatically reduced if the grass and weeds in the egg-laying sites were burned with fire. He burned fence lines between November 1 and May 1, and reduced the borer population by 82-97% in those weedy areas.

During the past two years, we have burned grass terraces or fence lines and evaluated the impact on corn yields in the adjacent rows. These burned areas were next to cornfields where stalk borers had caused noticeable damage during previous years. Therefore, we assumed that the moths had laid their eggs in these grassy sites again and that by burning we could greatly reduce the amount of damage the larvae would cause to corn. We burned in late March or April and this was for two reasons. We did not want to burn in the fall because this would eliminate most of the grass cover from the terraces and expose them to unnecessary erosion. Second, burning during this time period does not have a detrimental effect on grass regrowth.

Two treatments were used - burned and nonburned. Treatments were 50 feet long in each terrace or fence line and replicated five times. Although each plot was 50 feet long, we only used the center 13-17.4 feet (1/1,000 acre) of corn in the first row adjacent to each plot. Stakes were used to mark off the 1/1,000 acre and a uniform plant population was established across all plots for each field. The percent infested plants was later evaluated after the larvae had migrated out of the grass. Corn ears were collected at the end of the season to measure yields.

Data were collected from six fields and the results were mixed. Five fields had yield increases of 8, 11, 22, 29, and 68% in the corn rows adjacent to the burned grass. One field, however, had 8% less corn next to the burned area. The numbers have not yet been statistically analyzed but true yield increases because of the burning can probably be assigned in three of the six fields.

There are several reasons for the variability between the burned and nonburned areas. First, we must realize that if eggs are laid in grasses out between the corn rows, then this area will not get burned. Grassy weeds out in the rows have been flattened by winter snows and usually are not dense enough to carry a fire. Grasses in the row was the problem in several fields where the first 2-3 rows were choked with foxtail at the end of the growing season. We can probably correctly assume that the foxtail was there last year also and the moths laid their eggs out in these grasses. Therefore, if burning is to be at all successful, then grass control in the corn must be achieved. Second, we have seen differences in infestation levels in corn next to the unburned areas and this is most likely a result of moths laying more or less eggs in these areas. Some grass terraces contain a diversity of weeds and plots with high populations of smartweed had fewer stalk borers coming from those plots. Third, because moth eggs are laid on grasses in the fall, it is possible for leaves and stems to break off and get blown out into the field, thereby spreading the insects. Likewise, a fire would not kill these larvae either but this is probably not a major factor contributing to the differences we saw. Burning of grassy areas holds the greatest promise where grassy-weed control is attained in the cornfield.

An Integrated Pest Management Approach

The best approach to managing stalk borers in corn is to integrate a variety of options that fit an individual field situation. The following strategies are potential options.

1. Determine which fields have a history of stalk borer problems or the potential because of grassy weeds.

2. In fields without grassy-weed problems, burn grass terraces, ditches, waterways, etc. in early spring before grass begins to green up.

3. If grass areas are not be burned, spray egg-laying sites with a pyrethroid at 575-750 oF degree days or

4. If grass areas are not be burned, scout the first two corn rows for migrating larvae and leaf injury at 1,400oF and 1,700oF degree days. Use the economic injury level table to determine if an insecticide application is justified.

5. Fields with historical, field-wide stalk borer infestations should apply an insecticide to coincide with the grass kill from the herbicide. Either tank mix with a fast-acting herbicide or apply several days after a slow-acting herbicide.

6. Eliminate grass problems in the field before egg laying begins in August.

Table 1. Economic injury levels (expressed as a percentage of infested plants) for corn attacked by stalk borers under different growing conditions and yield goals. This chart is for corn valued at $2.00 per bushel and management costs of $10 per acre (Davis and Pedigo 1991).

	EIL under adequate moisture		EIL under drought stress	
Leaf stage	125 bu./a	150 bu./a	50 bu./a	75 bu./a
1	15%	12%	24%	13%
2	18%	15%	26%	14%
3	23%	19%	28%	15%
4	25%	20%	30%	16%
5	25%	21%	30%	16%
6	50%	41%	45%	23%
7	100%	100%	66%	33%

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