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European Corn Borer in Mississippi Cotton

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Abstract

The European Corn Borer, *Ostrinia nubilalis* (Hübner), is a major pest of corn that occasionally feeds on cotton. Cotton pest status of the European Corn Borer may be increased when insecticide treatments are reduced on cotton fields or when adjacent corn acreage is increased. During 1993, observations in field plots located in Leflore County, Mississippi, indicated that boll damage from European Corn Borer larvae reached levels as high as 25% in untreated plots late in the season. Boll damage associated with European Corn Borers in plots sprayed for tobacco budworm, *Heliothis virescens* (F.), and corn earworm, *Helicoverpa zea* (Boddie), was as high as 20%. Damage to bolls in transgenic cotton expressing insecticidal protein of *Bacillus thuringiensis* Berliner was less than 4%.

Introduction

The European Corn Borer (ECB), *Ostrinia nubilalis* (Hübner), is a major pest of corn in some regions of the United States. The insect (Figure 1) was introduced into the U.S. from Europe in the early 1900s (Metcalf and Metcalf 1993) and rapidly spread across North America. It has a broad host range, including both monocots and diocots, that varies with climate, number of generations, and availability of preferred hosts. ECB in northern regions of the U.S. Corn Belt may have a single generation that feeds primarily on corn, while those in southern regions may have three or more generations utilizing a variety of hosts (Showers et al. 1982). The ECB is a recognized pest of corn, sweet corn, potatoes, beans, numerous vegetables, and flowers. It feeds on more than 200 plants, including many weeds. In recent years the ECB (Figure 1) has been recognized as a potential pest of cotton, particularly in the Carolinas, where agricultural production includes a wide diversity of plants.

Figure 1. European Corn Borer larva on a cotton leaf. The body of the larva is typically pale brown or pinkish gray with dark middorsal lines on abdominal segments

In North Carolina the ECB prefers to oviposit on corn in the silking stage but will shift oviposition to cotton, particularly flowering cotton, once the corn silks dry and plants senesce (Savinelli et al. 1988). Small larvae feed on the undersurface of cotton leaves for approximately 1 day before they bore into plant structures (Savinelli et al. 1986). This boring behavior leaves a characteristic sawdust-like frass (Figure 2). During early to middle stages of crop phenological development, this boring activity results in a wilted terminal or leaf that can be easily recognized by trained scouts. This damage resembles drought stress, but plants directly adjacent to the infested plant will not indicate drought stress. Verification of the ECB infestation can be accomplished by examining the wilted plant for characteristic entrance holes with sawdust-like frass (Figure 2). Later in the season, larvae tunnel into the main stem or large lateral branches (Figure 3). This activity can result in stem breakage and lodging of the plant. Near the end of the season, larvae feed directly on bolls located in the middle to lower portion of the plant canopy. They typically enter the boll near the calyx (Figure 4). This characteristic feeding at the base of the boll is often distinguishable from damage by the tobacco budworm or corn earworm, which usually occurs higher on the boll.

According to C. Parencia and colleagues who compiled annual reports of cotton insect counts and control (Anonymous 1984), the ECB was first reported as a pest of cotton in 1955. A few plants were found to be infested in a cotton field in Franklin County, Tennessee. Subsequent infestations were reported in Alabama, Florida, Louisiana, Mississippi, South Carolina, and Tennessee, but the insect never became a major pest of cotton until recently in the Carolinas.

Recent changes in agricultural production may contribute to an elevation in the pest status of the ECB in cotton in Mississippi. The Boll Weevil Eradication Program has successfully eliminated the need for many insecticide applications in the Carolinas, Georgia, and Alabama. Most of Mississippi is currently in the early stages of the eradication process. Reduced use of insecticides directed at the boll weevil, *Anthonomus grandis grandis* (Boheman), may have contributed to the increased incidence of ECB damage to cotton in the Carolinas. Increased corn acreage in the South has more than likely encouraged population growth of the ECB. Commercial development of transgenic cottons and corn expressing endotoxin proteins of *Bacillus thuringiensis* Berliner may influence pest status of the ECB in regions growing both cotton and corn. These transgenic crops are highly effective against the ECB, and populations should be reduced within the crops. However, resistance management strategies for these transgenic crops require establishment of refuge (nontransgenic) areas that are usually unsprayed or insecticide-sprayed acreage of the crop. These unsprayed refuges of both crops may be attacked by the ECB.

Reported in this study are observations of ECB damage to cotton in Leflore County, Mississippi, during 1993. These observations were made in 2-hectare research plots designed to measure differences in arthropod activity between unsprayed nontransgenic cotton, nontransgenic cotton managed and sprayed for cotton insects, and unsprayed transgenic cotton expressing insecticidal protein of B. *thuringiensis* (Bt cotton).

Figure 2. Characteristic sawdust-like frass created by European Corn Borer larva after tunneling into the cotton stem.

Figure 3. European Corn Borer larva and tunnel exposed by splitting the main stem of an infested cotton plant.

Figure 4. Small European Corn Borer larva that has initiated feeding at the calyx of a cotton boll. (Photo provided by the Mississippi Entomological Museum, David Young collection).

Materials and Methods

A multi-year (1992-1994) field project was conducted on the Makamson Planting Company Production Farm in Leflore County to measure the impact of transgenic cotton expressing the endotoxin protein of B. *thuringiensis* on arthropods associated with cotton. The experimental design was a randomized complete block design with one replicate of each treatment per year for three consecutive years. Each treatment was approximately 2 hectares bordered by non-Bt buffers as mandated by USDA/APHIS. The experiment included three treatments: (1) a transgenic cotton expressing endotoxin protein (Bt) without foliar applications of insecticide for Lepidoptera; (2) a nontransgenic cotton not treated for Lepidoptera (CK); and (3) a nontransgenic cotton, which received insecticide applications for control of Lepidoptera (MGMT). Insecticide applications for non-lepidopteran pests in all plots and for Lepidoptera in the MGMT plot were based on routine scouting and recommendations of the agricultural consultant responsible for the commercial cotton acreage on the farm. The test area was surrounded by commercial cotton and corn production. The transgenic cotton was Line 757, an experimental cotton from the Monsanto Company that expresses Cry1Ac protein. The nontransgenic cotton was 'Coker 312,' the parent line for Line 757. During 1993, the year observations on ECB were collected for this report, Bt and CK plots each received a total of three applications of insecticide for control of non-lepidopteran pests. The MGMT plot received 10 applications of insecticide for all pests. Yields of the Bt, CK, and MGMT plots were 684, 529 and 630 kilograms of lint per hectare, respectively, during 1993. The commercial cotton grown adjacent to the study area yielded approximately 956 kilograms of lint per hectare. The difference in yield between the MGMT and commercial cotton was most likely due to variety differences.

All three plots were sampled weekly by sweep net and visual observations to record densities of arthropods and amount of fruit damage. During late July and early August, corn borer damage was observed. The characteristic frass (Figure 2) and wilting of terminals caused by ECB became more prevalent as the season progressed. Larvae were collected and taken to the Clay Lyle Entomology Complex at Mississippi State University for identification. Visual identification of larvae by staff at the Mississippi Entomological Museum and subsequent identification of adults reared from larvae collected in the field confirmed that the insect causing damage was the ECB. As the damage increased, more attention was given to field observation and sampling procedures. Terminals of 50 plants per plot were randomly sampled on August 24, August 31, and September 9, 1993, to record percent of plants infested by ECB larvae. On September 2, 1993, 80 plants from each plot (Bt, CK, and MGMT) were destructively sampled to measure incidence of stalk damage, presence of ECB larvae in stems and bolls, and amount of damage to bolls. Subsequent observations were made in adjacent commercial cotton to quantify the distribution of ECB damage.

Results and Discussion

The percent of cotton terminals damaged by the ECB increased in CK and MGMT plots during late August and early September (Figure 5). A more thorough examination of entire plants revealed higher levels of damage to stems than recorded by terminal observations (Figure 6). About 30% of the CK plants had stem damage, and 15% of the MGMT plants had stem damage. Some stem damage (0.4%) was detected in the Bt plot, but the frequency was less than the expected frequency of plants genetically lacking endotoxin protein (approximately 2% non-expressing plants within the Bt plot). More than 15% of the bolls in the CK and MGMT plots contained ECB larvae. Less than 2% of the bolls in the Bt plot had ECB larvae.

Boll damage was high (more than 20%) in both CK and MGMT plots (Figure 7), compared with the Bt plot, indicating that insecticidal applications timed for tobacco budworm control were not effective in controlling ECB. Some boll damage from the ECB and the tobacco budworm/corn earworm was recorded in the Bt plot, but the amount was low and much less than that for the CK and MGMT plots.

Subsequent surveys of adjacent commercial cotton revealed only occasional damage from ECB larvae. Most of the boll damage seemed to be localized around our study area. Since corn was also grown adjacent to the plots and the Bt and CK plots received only a few insecticidal applications, this could have created an ideal environment for survival of the ECB moving from corn into cotton. The observation dates for first detection of the ECB in cotton support the finding of Savinelli et al. (1988) that the ECB female will oviposit on cotton once corn silks have dried and the plants begin to senesce.

The characteristic wilting of terminals and accumulation of frass near entrance holes on the stem (Figure 2) are indicators of ECB. However, the magnitude of boll damage was greater than expected based on visual observations of the upper plant canopy. Standard monitoring procedures for tobacco budworm/corn earworm underestimated the late-season damage. According to Mason (1996), egg masses occur deep within the plant canopy and cannot be easily found; therefore, scouting efforts should focus on detecting early instar larvae in bolls between bracts and the boll wall. They suggest using a threshold of 3% of the plants with live larvae if the larvae have not tunneled. If the ECB is suspected as a pest in the cotton, scouts are encouraged to make whole-plant samples and inspect bolls at lower locations in the plant canopy. Bolls should be examined for ECB larvae feeding near the calyx (Figure 4) at the base of the boll. Although the larvae may not penetrate into the lint, the destruction of tissue at the base of the boll may cause the boll to abort.

The use of pheromone traps or black light traps to monitor adult activity provides an indicator of time periods when ECB scouting should be intensified. During 1998, high populations of ECB adults were observed in Leland, Mississippi (Angus Catchot, personal communication). Harstack Heliothis-type moth traps (2) were placed within the canopy of soybeans at this location. One trap was baited with pheromone associated with the IOWA strain of ECB and one with the New York strain of ECB. Traps were monitored on two dates. The number of moths collected were (IOWA: New York) 53:9 for July 28 and 214:31 for August 5. Sixty larvae collected from this location were sent to C.E. Mason of the Department of Entomology and Ecology at the University of Delaware. Upon emergence, the pheromone composition of virgin females was analyzed by gas chromatography. All females from this study produced pheromone recognized as IOWA strain. However, other geographic areas may have a different pheromone type than these reported.

Successful eradication of the boll weevil, expanded use of transgenic crop plants, and increased crop diversity may create crop environments with less intensive use of broad-spectrum insecticides. Reduced insecticide inputs may also create an opportunity for improved management systems. Changes of this magnitude will alter the complex of arthropod pests feeding on cotton. Accurate detection of damaging pests, particularly the recognition of new pest problems, will be important to effective crop management in a changing environment of new technology. Refuge crops grown to assist in the management of pest resistance to transgenic cotton and corn may be ideal habitats for ECB populations. Growers and consultants are encouraged to consider these crop interrelationships when making their pest and crop management decisions. Additional research should focus on verifying ECB types across Mississippi, as well as refining scouting techniques and thresholds for cotton. Comparisons between black light and pheromone traps should be studied to determine which trap type provides the most reliable indication of adult activity in Mississippi.

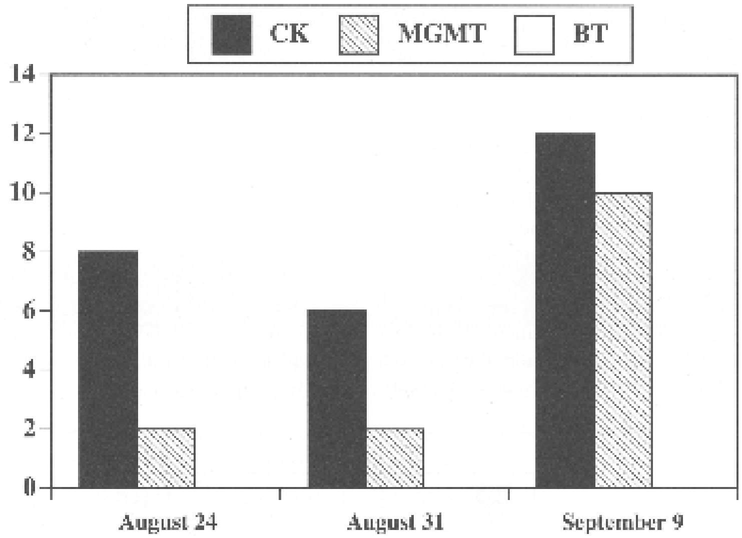
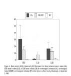


Figure. 5. Percent of plants in nontransgenic untreated (CK), nontransgenic treated (MGMT), and transgenic untreated (BT) cotton plots infested with European Corn Borer in Leflore County, Mississippi, 1993.



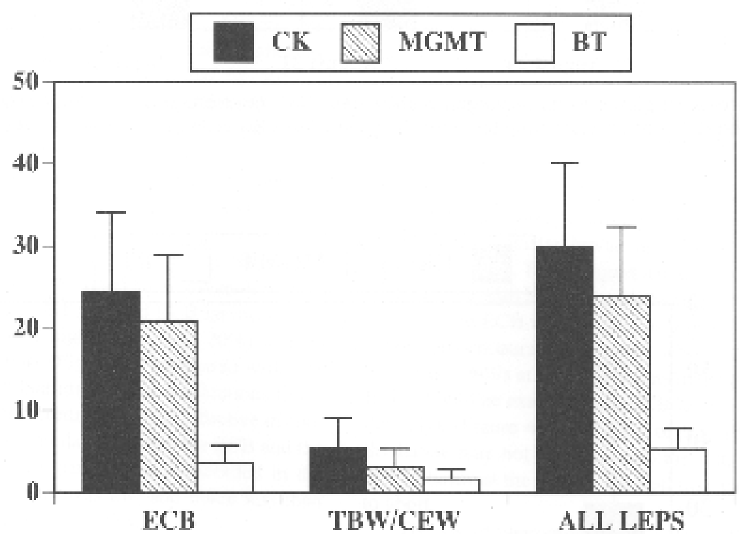


Figure. 7. Mean percent (SEM) of cotton bolls damaged by European Corn Borer (ECB), Tobacco Budworm/Corn Earworm (TBW/CEW) and all lepidopteran (ALL LEPS) larvae in nontransgenic untreated (CK), nontransgenic treated (MGMT) and transgenic untreated (BT) cotton plots in Leflore County, Mississippi, on September 2, 1993.

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