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INSECT MANAGEMENT IN SEED CORN PRODUCTION

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Overview

Corn grown for seed is often affected by the same pests as are found in corn grown for grain. However, integrated pest management (IPM) decisions can be considerably different from those in grain production. This is because inbreds are typically less tolerant than hybrids to stress from pests and the value of the seed is considerably greater than corn for grain.

European corn borer and corn earworm are probably the two most significant economic insect pests in seed corn production fields. Following is a summary of the highlights of research conducted at Pioneer Hi-Bred International and experience from seed production fields regarding key components of IPM decision making for these insects.

European Corn Borer - Ostrinia nubialis

Establishing Economic Injury Levels

Most research on managing European corn borer (ECB) has been conducted on hybrid genotypes and corn produced for grain. As a result, economic-injury levels (EIL’s) and thresholds for use in the production of hybrid seed corn were often extrapolated from those used in grain production, with some nominal "adjustments" to reflect the greater value of corn grown for seed.

Although the value of the crop is central to IPM decisions and should be considered, extrapolating from research on hybrids assumes that the yield-loss relationships describing the effects of corn borer infestations on inbreds are the same as that on hybrid genotypes. Because of the uncertainty about whether existing guidelines for IPM decisions, derived from research with hybrids, we conducted research on inbreds. ECB infestations were established on selected inbred genotypes during the whorl-stage or at flowering (ECB1 and ECB2, respectively) to develop EIL’s for use in seed corn production.

Due to constraints for time and space, only a subset of inbreds could be included in our experiments to develop EIL’s for ECB on seed corn. We chose to work with three inbreds that are currently important seed parents. Based on data developed by our plant breeders, who continuously evaluate our proprietary genetics for tolerance to ECB1 and ECB2, these inbreds were characterized as sensitive to moderately sensitive.

Small-plot experiments were established at a total of five locations in 1988 and 1989. Because field scouting and management decisions at Pioneer are based largely on the percent of plants infested with ECB, these studies were designed to simulate seed production fields with various
levels of infestation (0 to 84% of plants infested with newly-hatched larvae). Separate but identical experiments were established for ECB1 and ECB2 by infesting with newly-hatched larvae during the mid-whorl stage (ECB1) or at flowering (ECB2). Analyses focused on the effects of the infestations on yield, both in terms of bushels per acre and saleable seed (i.e., 80,000-kernel units) to evaluate from the standpoint of the seed grower and seed company, respectively.

Results of this research showed that infestations of either ECB1 or ECB2 resulted in significantly reduced yields of the inbreds; however, the responses were consistent across the inbreds tested. Comparatively, infestations of ECB1 resulted in greater yield losses than ECB2, although both were significant.

To be most useful, EIL's should be dynamic, reflecting the expected yield, the value of the crop, expected levels of control and costs of control. For the purpose of illustration, the yield-loss relationships established in these studies on inbreds were used with fixed estimates of the other factors that affect the EIL, such as value of the crop, costs and expected levels of control.

If infestations of ECB1 reach economic levels, one application of an insecticide is usually sufficient to manage the problem. Therefore, for purposes of calculating an EIL for ECB1 and establishing the level of yield loss that would need to be expected before applying an insecticide would be justified, it was assumed that a single application would be needed at a total cost (product + application) of $10.00 per acre. The anticipated level of control is needed to estimate preventable yield losses through timely management. Based on research over the past three years in seed production fields, our data would suggest that 70% control of ECB1 is a realistic expectation.

With these assumptions, and considering the value of the seed corn to be equal to the costs of production (i.e., not the potential market value of the seed), an approximate EIL for ECB1 would be when greater than 5% of the plants of the seed parent are infested with newly-hatched or larger larvae.

The same analysis was conducted for ECB2. However, two applications of an insecticide are often needed to achieve 70% control of ECB2, at a total cost of $20 per acre. With this scenario and the yield-loss relationships derived from these experiments, the EIL for ECB2 on seed corn would be exceeded when more than approximately 15% of plants have eggs masses or small larvae feeding in the leaf axils.

Based on the results of these experiments, it is apparent that thresholds for ECB1 and ECB2 in seed corn are considerably different from those commonly used in hybrid corn produced for grain. Oftentimes, EIL's for ECB1 and ECB2 on hybrids in grain production approach 50 to 75% infestations while the results listed above suggest treatment on seed corn would be economic when infestations exceed 5 or 15% for ECB1 or ECB2, respectively. Reasons for these substantial differences relate to the fact that seed is of greater value (i.e., approximately 6X in these analyses) AND inbreds appear to be more affected by ECB infestations than hybrids.

Timing Insecticide Applications

To effectively manage ECB1, insecticides must be applied when the larvae are relatively small and feeding where they will be exposed to the insecticide BEFORE they begin to tunnel deep
into the whorl and begin to bore into the stalk. Our experiences have indicated that, to be most effective, insecticides should be applied when the majority of the insects are third instars or smaller. Instar guides for ECB larvae are available to assist scouts in accurately assessing larval age/size. However, most scouts have a tendency to overestimate age classes, especially of small larvae (e.g., oftentimes, second instars are mistakenly categorized as firsts, etc.). Errors of this kind can be very costly, if most of the insects are nearing the size when their feeding behavior is such that they are (or will soon be) no longer exposed to the insecticide. This is especially critical for the biological insecticides where the larvae must ingest the insecticide for mortality to occur.

Timing of insecticide applications is no less important for ECB2 than ECB1. For best results treatments should be applied when eggs are beginning to hatch and/or small larvae are feeding in the leaf axils. The greatest difficulty in the decision-making process for ECB2 probably rests with the fact that sampling for ECB2 is based primarily on finding eggs and/or small larvae on full-canopy corn plants. This is considerably more challenging than sampling for ECB1, when plants are knee- to waist-high. Frankly, scouting to obtain accurate and timely assessments of the develop of corn borer populations, especially for ECB2, is probably the weakest link in current IPM programs for European corn borers in seed and commercial corn.

**Corn Earworm - *Helicoverpa zea***

**Larval Damage in Seed Corn**

Corn earworm (CEW) larvae can occasionally be found feeding in the whorls of corn plants. This damage is usually not economically significant, except under very high infestation levels which might be found in subtropical areas. Thus, it is the larvae that result from eggs laid on silks of developing ears that pose the greatest threat to yield and the quality of seed corn.

CEW larvae may feed on and consume entire kernels. However, even partially-eaten kernels can result in significant reductions in yields of saleable seed and higher production costs. Some insect-damaged kernels will be lost during harvest. The remainder are hopefully removed during seed conditioning. However, the total loss of saleable seed due to CEW larval feeding on kernels, or that from any other kernel-feeding insect, is always greater than the actual percent of kernels with feeding, because current gravity separation equipment cannot remove only damaged kernels. A general rule-of-thumb is that at least one good kernel is removed for every kernel with damage. As a result, if three percent of the seed has insect-feeding damage, at least six percent of the seed will be removed during gravity separation.

To better understand the effects of CEW infestations on seed corn, ear samples were collected at several seed corn production locations across the central Corn Belt of the U.S. Yield losses were calculated based on damaged kernels removed from samples. This information suggested that if 10% or more of the plants have live larvae feeding in the ear, then economic losses would be expected. Thus, a simple nominal economic threshold for CEW would be when eggs can be found on a total of 10% or more of the ears in a field.

In reality, a static threshold such as this is of limited value. For example, it is suspected that husk characteristics (tight vs loose) and pollination have an effect on the amount of damage caused by a CEW larva. Ears that are partially pollinated and/or have loose husks are probably subject to greater kernel feeding, due to the increased mobility of the larvae on the ear. In addition, poorly pollinated ears can be subject to egg laying over an extended period of time.
This is due to the fact that silks which are not pollinated will stay green and be attractive longer, which increases the opportunity for CEW egg laying. Without more specific information on how to adjust thresholds for these and other factors, use of a simple threshold is required.

**Timeliness of Decision Making**

The time between egg hatch and movement of CEW larvae under husks of the ear has been reported to be as short as a few hours. This information is critical for developing and implementing management strategies because any insecticide applications need to be timed so that the insecticide is present when the larvae hatch. Any attempts to manage CEW larvae after they move under the husks of the ears are not likely to be successful.

Our field data indicate that CEW eggs begin to hatch approximately 60 GDU after being laid on corn silks. Newly hatched larvae feed on silks near the ear tip for up to 40 GDU before moving inside the husk. Thus, the total “time” between egg laying and when the larvae would no longer be “exposed” at the ear tip would be approximately 100 GDU from the time that the eggs are laid. To be effectively managed, scouting, decisions to treat and application of an insecticide must occur within this “100 GDU window”.

**Monitoring Corn Earworm Populations with Pheromone Traps**

Pheromone traps are designed to monitor populations of selected adult insects. Traps are baited with a lure that emits a synthetic chemical that mimics the sex pheromone of the female. Typically, the pheromones in these lures are very specific; as a result, the traps usually capture only the species desired. However, only male insects are attracted to these sex pheromones. This is in marked contrast to blacklight traps, that are often used for monitoring populations of various moths. Blacklight traps typically capture both sexes of a wide range of species. Thus, more effort is usually required to sort through the various insects captured with blacklight traps.

Two kinds of pheromone traps are commonly used for monitoring populations of CEW moths - the “Hartstack” or “Texas A&M” Trap and the Scentry® Trap. The Hartstack Trap is constructed from hardware cloth or screen while the Scentry Trap is made of nylon. Comparisons between the two traps suggest that the Hartstack is probably the superior trap design. Unfortunately, this trap may not be available from commercial suppliers. If this is the case, the options would be to construct the screen trap or use a commercially-available nylon trap such as the Scentry Trap. With either trap, male moths are attracted to the pheromone at the bottom of the trap, fly upward through the large opening at the bottom of the trap and are captured in the top part of the trap.

Pheromone traps for CEW should be in position near seed fields of earliest maturity at least one week before silk is expected. Traps should be placed no more than approximately 50 feet from the nearest corn and located on the appropriate side of the field to capitalize on prevailing winds to carry the pheromone into the field. Traps should be placed so that the bottom is approximately three feet above the ground. As the season progresses, traps should be moved to fields or growing areas where fresh silk is present, to monitor mid- and late-maturity seed fields, especially if the number of available traps is limited.
Pheromone lure placement within the trap is also important. The pheromone lure should be placed at the bottom of the cone trap near the center. Lures should be replaced every 7-10 days. Old pheromone lures must be disposed of properly away from the trap site.

Uses and Abuses of Pheromone Trap Data

The use of pheromone traps in IPM programs for corn earworms was initially developed and used mostly in the production of sweet corn for fresh and processing markets. The traps are set up near production fields prior to silking and checked daily for moth captures. In sweet corn, most producers consider that a pheromone trap catch of 10 or more CEW moths per night for two consecutive nights during silking is an indicator that economic damage is likely. When the threshold for moth captures is exceeded, sweet corn producers normally apply an insecticide.

A similar system has been used in seed corn, whereby catches of moths in pheromone traps have been used to determine if and when applications of an insecticide are necessary to protect ears from CEW damage. Although the pheromone traps are useful indicators of the potential for CEW damage, there are several limitations. First, pheromone trap captures do not necessarily indicate that egg laying is occurring at economic levels in adjacent seed fields. This is related, at least in part, to the fact that only male earworm moths are captured in pheromone traps. Secondly, trap captures are not necessarily well correlated with actual CEW populations in specific seed fields.

In the production of seed corn, where there may be 100 or more fields in a growing area, it is not feasible to employ and maintain a separate trap for each field. Thus, the traps are used to characterize the overall population levels of CEW and estimate the threat of infestations across fields. This leads to the question, “How many traps are needed to adequately sample the population of CEW moths in a production area?”.

Data collected in 1991 by Pioneer personnel at the Good Hope, Illinois and Doniphan, Nebraska Production Locations were analyzed to examine the variation in trap catches between growing areas and between traps within a growing area. Results indicated that wide variation in moth catches can be expected from one trap to another. For example, one trap might catch 20 moths in a night while another trap, located within two miles, captures none. As a result, to adequately characterize the CEW population for an area, the average moth catch from several traps is needed. Each growing area should be considered and monitored as an individual unit. Results of these analyses suggested that at least 3 and up to 9 traps are needed within a growing area. These estimates were fairly consistent, despite the fact that the growing areas at Doniphan were considerably larger (120-200 square miles) than at Good Hope (14-40 square miles).

Despite the many benefits of using pheromone traps to monitor CEW populations, relying entirely on a moth monitoring program as the basis for decisions to treat seed fields for CEW can occasionally be misleading and perhaps lead to unnecessary spraying. For example, at Good Hope, Illinois in 1993, moth catches were at or above the threshold of 10 moths per night in five growing areas, which suggested that an insecticide treatment was needed for control of CEW. If spraying had been initiated based on moth counts only, the expected cost for treating all five of the growing areas with a single application of an insecticide would have been approximately $85,000. However, after scouting fields for CEW eggs, in an effort to confirm that the CEW moths were laying eggs at significant levels, it became evident that the actual
percentage of plants with eggs in the field or growing area was well below the threshold of 10 CEW eggs per 100 plants. Thus, treatment was not warranted. These results suggest that the best strategy for determining if and when to protect seed fields from CEW is probably based on a combination of a pheromone-based moth monitoring program and field scouting for eggs.

Enhanced Scouting Programs for Determining the Need to Treat for Corn Earworms

Monitoring CEW moth populations with pheromone traps is the first important step in determining whether seed fields are at risk of economic damage from CEW. Trap catches provide information on when moth flights occur and the POTENTIAL for CEW infestations. Thus, the pheromone monitoring program is most useful to determine when intensive scouting of seed fields for egg laying should occur.

As trap catches approach the threshold level of 10 moths per night, scouting for CEW eggs on silks should be initiated. It is important to scout EACH inbred which has fresh silk within a growing area. If not all fields can be scouted, at least a subsample of representative fields should be scouted.

If egg counts for a field or area reach or exceed the threshold (10 eggs per 100 plants IF silks are removed and examined for eggs outside the field, OR 10% of plants with eggs if examined in the field.) then an insecticide spray should probably be applied to the field as soon as possible. If the infestation of eggs is less than threshold, then it is advisable to scout for eggs again within two days. If after scouting the field or area again and the cumulative infestation level (i.e., infestation level from first egg scouting PLUS that from second scouting) exceeds the threshold, then an application of an insecticide is likely justified.

As the availability of fresh silk is exhausted in the area, monitoring of moth flights is still important until silks are brown and begin to fall from the ears. This is important because, as the availability of fresh silk decreases, moths may begin to lay eggs on brown silk. It is suspected that earworms which hatch from eggs laid on brown silk will move quickly into the ear, due to the reduced suitability of the brown silks as a food source for the larvae.

Scouting is the Key

Effective IPM programs are more important than ever to minimize costs in the production of hybrid seed corn, while providing the highest level of protection to field workers and natural resources. Although European corn borer and/or corn earworm can occur wherever seed corn is produced in the U.S., neither insect is always present at economic levels. Herein are opportunities to apply the principles of IPM to determine when and how to manage these insects most effectively. However, with the greater value of corn grown for hybrid seed versus hybrids produced for grain, and the resulting lower economic thresholds, investing the appropriate amount of time and other resources to effectively scout seed production fields on a regular basis is critical to maximize productivity.