

IOWA STATE UNIVERSITY
2003 CORN INSECTICIDE EVALUATIONS

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IOWA STATE UNIVERSITY
2003 CORN INSECTICIDE EVALUATIONS

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Introduction

The corn rootworms, *Diabrotica virgifera virgifera* (western corn rootworm) and *D. barberi* (northern corn rootworm), are the most serious pests of *Zea mays* (corn) in the United States Corn Belt. Eggs are laid in the soil during the fall and hatch the following spring. Larval feeding on corn roots in June not only causes physiological yield loss, but also results in harvesting losses because of plant lodging. Adult emergence from the soil is underway by early July and continues through late summer. Additional crop losses can be caused by the beetles feeding on the female flowers (silks) and soft kernels. In Iowa, crop rotation, where it fits cropping practices, remains our preferred method of control. However, it is also economically feasible to protect corn roots with insecticides and transgenic seedcorn that contains naturally occurring soil bacterium *Bacillus thuringiensis* (*Bt*).

Objective

Our goal is to serve Iowa agriculture by monitoring performance of registered insecticides and evaluating new chemical and transgenic tools that are more economical, efficacious, and environmentally compatible. Given this end, we maintain a viable, progressive, and scientifically sound product evaluation program.

Testing Procedures and Evaluations

Field Selection – Product efficacy test plots were established at nine Iowa locations in 2003. Corn rootworm (CRW) research areas are continually maintained on

University farms located at: Ames-Johnson Farm, Crawfordsville-SE Research Farm, Kanawha-Northern Research Farm, Nashua-NE Research Farm, and Sutherland-NW Research Farm. Each research area is divided into two sections, which annually alternate as test plot and late-planted trap crop. The seed used for the trap crop is a mixed-maturity blend with a greater proportion of late-maturing varieties. The trap crop constitutes a favorable environment for adult females late in the season when other fields are maturing.

The seedcorn maggot (SCM) test was conducted at the Ames-Johnson Farm. A baiting technique was used to attract ovipositing adult flies.

White grub tests were established in perennial problem fields near Williams in north central Iowa and near Kimballton in the southeastern part of the state. Early spring sampling revealed the presence of true white grubs.

Two wireworm tests, Ames and Carlisle, were conducted in the fields of private growers. The Ames field had been in sod for 20+ years and early spring “bait stations” (a buried corn and wheat mixture) confirmed the presence of wireworms. The Carlisle field was a replant situation. The stand had been reduced to less than 5,000 plants/acre by a combination of wireworm and white grub feeding.

Table 1 lists the type of test(s) conducted at each location, target pest, and other general plot information. CRW insecticide treatments were tested in three different types of tests: (1) **Experimental Tests** - registered and developmental insecticides applied at planting time; (2) **Yield Tests** - only registered and Experimental Use

Permit products applied at planting time; (3) **Large-Scale YieldGard Rootworm® (YGRW) Yield Tests** – transgenic CRW seed, registered insecticides applied to non-transgenic seed, and a non-transgenic-seed check.

Field Plot Design and Application Techniques - Experimental unit size and number of replications for each test are shown in **Table 1**.

Corn Rootworm Tests:

The experimental design in the *yield* and *experimental tests* was a randomized complete block (RCB) with four replications. Treatments were applied to single 50-ft rows in the experimental tests and two 100-ft rows in the yield tests. The *YieldGard Rootworm Yield tests* consisted of a RCB with four to twelve replications and four-row treatments. Dependent on field space, row lengths were either 100 or 200 ft. Seeds were pre-bagged and planted with a 4-row John Deere Max-Emerge™ 7100 integral planter that had 30-inch row spacing. The standard planter fiberglass seed hoppers with attached “finger pickup mechanisms,” were replaced with modified units. On the new units, the metal plate that covered the “fingers” had been replaced with a 7/8-inch, clear plexiglas plate. Inserted through the plexiglas was a small stainless steel cylinder. The cylinder was positioned to deliver seed to the “pickup fingers.” At the beginning of each replication pre-bagged seed was dumped into the steel cylinder. At the end of each replication, a hydraulic motor (attached to the planter’s drive shaft) was activated to expel any unplanted seed. Granular insecticide formulations were applied with modified Noble® metering units mounted on the planter. The Noble units were calibrated in the laboratory to accurately deliver material at a tractor speed of 4 mph. Plastic tubes directed the

granular treatments to either a 7-inch band ahead of the closing wheels (T-band, All-Terrain Banders), or to the seed furrow, placing all the insecticide directly in-furrow (Furrow). Wind shields were positioned around each row to prevent insecticide displacement. The wind shields consisted of a metal “U-frame” positioned parallel to the ground, above and surrounding each row’s press wheels; the open end was adjacent to the gauge wheels. Eleven-inch poly-bristle skirts were attached to the frame and the frame positioned so the bristle tips touched the ground. Each row was constantly monitored to ensure that insecticides were correctly applied at all times. Final incorporation was accomplished with drag chains mounted behind the closing wheels.

The Capture® 2EC liquid planting-time treatments were applied with a compressed-air system designed and built directly into the planter by Almaco manufacturing (Nevada, IA). This closed handling system consisted of 3-gallon product canisters equipped with quick disconnects. T-band and furrow treatments were applied with TeeJet® XR80015 spray nozzles at 21 psi to deliver 5 GPA of finished spray.

Aztec® 4.67G and Fortress® 5G treatments were applied with modified SmartBox™ metering units. Commercial metering units were removed from their large-base containers and sandwiched between a flat metal plate on the bottom and a custom-made, threaded plastic cap on the top. The bottom plate had been fabricated so that it could be slid in and out of the same planter mounting brackets used for the Noble units. An inverted 1000-ml Nalgene® bottle, screwed into the top cap, provided a secure and sealed container for insecticide. A short plastic tube attached to the dispenser opening of

the metering unit could be connected to either the planter's T-band or Furrow tubes. The controllers (2), mounted in the tractor cab, were used to operate the SmartBox metering units (2/controller). All treatments were applied at 4 mph using the "fixed speed mode" on the SmartBox controllers.

Wireworm and White Grub Tests:

The experimental design for these tests was a RCB, four replications, with treatments applied to single 50-ft length rows. The seed applications of Cruiser[®], Poncho[®], and Gaucho[®] were done commercially. All other seed treatments were applied by placing 300 to 650 grams of seedcorn in a 1-gallon plastic jar and adding the correct amount of seed-treatment formulation. The jar was then placed on a roller mill for mixing. All seeds, both treated and non-treated, were pre-weighed and bagged. Seeds were planted with the modified seed units described earlier. Granular insecticide formulations were applied with modified Noble or SmartBox metering units mounted the planter (described earlier). Capture[®] 2EC liquid treatments were applied with TeeJet XR80015 spray nozzles using 21 psi to deliver 5 GPA of finished spray.

Seedcorn Maggot Test:

The experimental design was a RCB, four replications, with treatments applied to single 20-ft rows. A meat-and-bone meal bait was used to attract ovipositing flies. The corn planter, with seed hoppers turned off and press wheels tied up, was used to premark rows. Hoes were used to make shallow row furrows. The bait was hand applied (~1/3 oz per row-ft) to the bottom of the open seed furrows on April 23 and again on May 1. Corn seeds were carefully placed by hand (8-inch seed spacing) directly into the bait on May 3.

Granular insecticide treatments were applied with modified Noble metering units mounted on a small-plot bicycle applicator. Seeds were covered with soil and the soil firmed by hand.

Corn Rootworm Larval-Damage Evaluations

Root-Injury – Five root systems were dug from each insecticide treatment row (center two rows of 4-row YieldGard Rootworm tests). Prior to transport back to Ames, roots were tagged for identification and excess soil was removed. In Ames, a pressurized water spray was used to remove the remaining soil. Roots were then evaluated for rootworm feeding injury on the following Iowa State Node-Injury Scale (0-3):

Iowa State Node-Injury Scale (0-3)

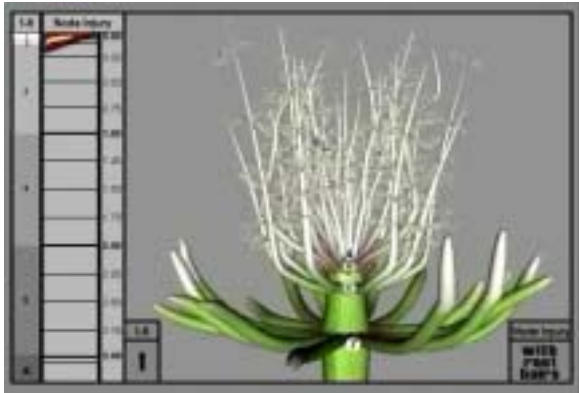
- 0.00 – No feeding damage (lowest rating that can be given)
- 1.00 – One node (circle of roots), or the equivalent of an entire node, eaten back to within ~ two inches of the stalk (soil line on the 7th node)
- 2.00 – Two nodes eaten
- 3.00 – Three or more nodes eaten (highest rating that can be give)

Damage in-between complete nodes eaten is noted as the percentage of the node missing, i.e. 1.50 = 1½ nodes eaten, 0.25 = ¼ of one node eaten, etc.

The linear Iowa State Node-Injury Scale allows injury to be expressed intuitively and is capable of quantifying very minor feeding. This scale has proved especially useful in evaluating minor injury, especially with transgenic seed corn. For an interactive

guide to the Node-Injury Scale, see the Iowa State University Entomology web site at:

rootworm/nodeinjury/nodeinjury.html



A product consistency (%) was also calculated for each treatment. Product consistency equals the percentage of times a treatment limited feeding injury to 0.25 node or less (greater injury can result in economic yield loss, especially when plants are moisture stressed).

To determine insecticide effectiveness, data were analyzed with standard ANOVA procedures. Ryan's Q Test (REGWQ) was used to rank treatment means where significant differences ($P > F \leq 0.05$) occurred.

Stand Counts - The number of plants in 17.5 row-ft was recorded.

Lodging Counts (Taken at harvest time) - A plant was considered lodged if it was leaning at least 30° from vertical. See individual table footnotes for length of row, or number of plants used to calculate percent lodging.

Yields - The Crawfordsville experimental test was hand harvested (17.5 row-ft). All other tests requiring yields were machine

harvested. Weights were converted to bushels/acre of No. 2 shelled corn at 15.5% moisture and analyzed for treatment effects.

Comments on Trials and Product Performance

Tables list treatment rates as ounces a.i. per 1,000 row-ft unless otherwise indicated in the footnotes.

AMES

YieldGard Rootworm (YGRW) Yield Test (Table 2): There was light CRW feeding pressure at this site with only 0.46 of a node eaten in the untreated check (UTC). Plants were not lodged and there were no significant treatment differences in stand counts or yields.

CRAWFORDSVILLE

Experimental Test (Tables 3-6): This site provided some extreme conditions for product evaluation; heavy rootworm pressure (2.14 nodes eaten in the UTC) and drought conditions during the summer (see weather table pp 49 & 50). Of the seven tests in 2003 that contained YieldGard Rootworm (YGRW) seedcorn, this is the only test where YGRW did not have a product consistency of 100 percent. Several plants had a half of node of brace roots eaten (7th node). There was volunteer corn in this field and the feeding could have resulted from larvae beginning development on the volunteer corn and then moving to the YieldGard Rootworm later in the season as the brace roots entered the soil. The concentration of the protein toxin in the later emerging roots may not have been high enough to control the large larvae. No lodging was observed with products that kept root injury below one node. YGRW and Cruiser ST 1.25 mg/seed were

the only two products with significantly higher yields than the UTC.

YGRW Yield Test (Table 7): This test was conducted adjacent to the above experimental test. Both tests were on “trap crop” ground and yields mirrored one another, even though this test was machine harvested (center two rows of four-row trt, 89 ft) and the experimental test was hand harvested (single row 17.5 ft). All other evaluations were also very similar. Even though Aztec provided good root protection, Aztec stand counts were numerically lower and may help explain its lower yield. YGRW yields were radically superior (+40 bu) to the best insecticide application. YGRW provided 100 percent product consistency in this test.

KANAWHA

Similar to the Crawfordsville location the *experiment* and *YGRW tests* were adjacent and on conducted on “trap crop” ground.

Experimental Test (Tables 8 & 9): There essentially was no feeding pressure on this portion of the field; and no significant differences in stand counts.

YGRW Yield Test (Table 10): There was slightly more feeding in this test (placed further into the field), but it was still very light (0.37 node in UTC). YGRW, Force 3G, and Aztec 2.1G had very little root injury, but both insecticides had significantly higher yields than YGRW. However, YGRW yields were not significantly different from the untreated isoline. The Kanawha location had adequate moisture throughout the growing season (see weather tables).

NASHUA

Yield Test (Table 11-14): Very heavy CRW pressure was seen in this test with 2.46 nodes injured in the UTC. Cruiser ST had very high root injury (1.84 nodes

eaten) and was not significantly different from the UTC in regards to lodging. YGRW and Force 3G T-band were the only two products that had significantly higher yields than the UTC. Nashua was extremely dry during July and August.

YGRW Yield Test (Table 15): This test was conducted on a continuous corn field that had 0.809 node-injury in the UTC and very light feeding in the other treatments. All products tested were significantly different from the UTC in regards to node-injury, product consistency, and stand count, but not to yields.

SUTHERLAND

Yield Test (Tables 16-19): Treatment yields were not significantly different from the UTC. Since this site had only moderate feeding (1.24 nodes eaten in the UTC), adequate moisture, and no lodging, we were not surprised by these results. Of interest here is that the Sutherland UTC yields were almost double those seen at Crawfordsville and Nashua (rain makes grain).

2003 YieldGard Rootworm Summary

Root injury and yield data from the six machine harvested plots (six different environments, 4-12 reps, 100-200 ft length rows) were separated into two groups – tests where the UTC was greater than 1 node, and tests where the UTC was less than 1 node – and analyzed for treatment differences (**Table 20**). Measurements from the two insecticides common to all tests, Force 3G and Aztec 2.1G, were averaged and represent the insecticide treatment. One of the environments where the UTC <1.00 node had moisture stress; two of the environments where UTC >1.00 node had moisture stress. It was not surprising there were no significant yield differences in tests where the UTC injury

averaged less than 1 node. In the other tests (>1.00 node), where two of the three locations had considerable moisture stress, only 0.33 node-injury limited yield potential by 21.8 bu/a. It was interesting there wasn't a much larger yield difference between the insecticide injury (0.33) and the UTC injury (2.02). The 7.4 bu/a difference was not significant.

Seedcorn Maggot Evaluations AMES

The baiting procedure did a good job of attracting ovipositing adults. Although there were no significant treatment differences in stand counts (**Table 21**), further inspection of the seeds/seedlings confirmed there was considerable injury. Following stand counts, seeds/seedlings were carefully extracted from two, 1-m sections of each row and inspected for feeding, and rated on the following 1-4 damage scale:

- 1 - seed/seedling undamaged
- 2 - seed/seedling damaged, but plant established
- 3 - seed/seedling damaged, plant showing some signs of stress
- 4 - seed/seedling damaged, no plant or questionable establishment.

Treatments that had a damage rating of 1.15 or less (13% percent damage) were significantly different from the BAITED CHECK (**Table 22**). Agrox Premiere and AGST 02002 were the only seed treatments that were significantly different from the BAITED CHECK.

White Grub Evaluations KIMBALLTON (Tables 23 & 24) WILLIAMS (Tables 25 & 26)

Plots were evaluated with the 1-4 damage scale described in the seedcorn maggot section. Untimely rains delayed planting 10-14 days at both locations. Grubs were present at both locations, but due to the late planting dates, feeding had evidently tapered off. Damage was very minor at both locations with no significant differences with any of the measurements.

Wireworm Evaluations AMES (Table 27) CARLISLE (Tables 28 & 29)

Plots were evaluated with the 1-4 damage scale described in the seedcorn maggot section. We were able to get the Ames test planted at a fairly early date, April 23. However, ground squirrels were well established in this sod field of 20+ years and caused considerable seed loss. An early check on the plot revealed ground squirrels digging up many of the seeds. Consequently plot evaluations were begun before wireworm feeding was completed. Missing seeds/seedlings due to "gopher damage" made stand count evaluations impossible. However, we were able to obtain damage ratings on four replications on May 12, and were able to add some later data to that from three replications on May 22.

A local agronomist called the Carlisle field one of the worst wireworm/white grub infestations he had seen. The field was located in a flood plain and was surrounded by many small willow trees. At evaluation time, many more white grubs were observed than wireworms. We replanted this field the day the cooperated field cultivated out the remaining stand, but the injury that occurred at this later date was very light.

Calibration Information

All Noble units were laboratory calibrated and units were randomly spot-checked in the field prior to planting. SmartBox units were calibrated on the planter in accordance with the SmartBox Operator's Manual instructions. During calibration and planting, the flowability of each formulation was noted, as well as any other calibration problems. There were no calibration or delivery problems with any treatment.

Agronomic Information and Weather Data

Agronomic information and field insecticide history for each test plot are listed in **Appendix I**. Weather data from the test site or the nearest Iowa Climatological Station are listed in **Appendix II**. Information on materials tested is listed in **Appendix III**.

Research Support

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