

Evaluation of Soil-Applied Insecticide and Bt Corn for Management of Larval Corn Rootworm in Central Iowa

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Introduction

The purpose of this study was to evaluate the effectiveness of Bt corn targeting corn rootworm and soil insecticide, either alone or in combination, for management of larval corn rootworm injury. The Bt trait packages evaluated in this study were DeKalb Smartstax RIB, Pioneer AcreMax Xtreme (AMXT), and Pioneer AcreMax Xtra (AMX). Also evaluated were two soil-applied insecticides—Aztec HC and Index CS.

Materials and Methods

Study location. The study was conducted at the Iowa State University (ISU) Johnson Farm, Ames, Iowa. The field site had been planted the previous year with a trap crop, which is a mixed-maturity blend with a greater proportion of late-maturing varieties. This trap crop constitutes a favorable environment for adult female rootworm late in the season when other fields are maturing, and results in a high abundance of rootworm larvae the following year.

Field plot design. This study was a randomized complete block design with four replications. Treatments were four rows wide, and 35 ft long. Plots were cut to 30 ft long after planting.

Planting. This study was planted May 8 and 9, 2018, using a four-row John Deere Max Emerge™ 7100 Integral Rigid Frame Planter with 30-in. row spacing. The study was planted at a depth of 2 in. with a spacing of 6 in. between seeds (35,600 seeds/acre).

SmartBox soil-applied insecticide. Aztec-HC 9.34G insecticide was applied with modified SmartBox metering units mounted on the planter. The commercial SmartBox 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. An inverted one liter plastic bottle attached to the top provided a secure and sealed container for insecticide used by the SmartBox units. Clear plastic tubes directed the granular insecticides to the in-furrow placement.

Liquid soil-applied insecticide. The liquid product, Index 2.80 CS, was applied in-furrow at planting with a compressed-air system built directly into the planter by Almaco manufacturing (Nevada, IA). Index 2.80CS was applied using Teejet XR80015EVS spray nozzles at 21 psi to deliver 5 GPA of finished spray at a tractor speed of 4 mph. The product used water as the carrier.

Before the season, two new spray nozzles were installed per row (T-Band & In-Furrow) and calibrated with water to ensure proper application of product. For the liquid application, each row was checked for correct spray pattern prior to application.

Rows were monitored during application to ensure all insecticides were applied correctly. Final incorporation was accomplished with drag chains mounted behind the closing wheels.

Stand counts. On June 18, 2018, early season stand counts were measured in all treatments. These were measured by using a 2 in. PVC pipe cut to the length of 17.4 ft (1/1,000 of an acre for 30-in. row spacing) and placed

between two rows of corn and the number of plants in both rows counted. Late-season stand counts were measured October 11, 2018, following the same procedure as early-season stand counts. Measurements for both dates were averaged to provide a single value for stand counts (Table 2).

Root injury. After the majority of corn rootworm larvae had finished feeding, roots were dug August 14, 2018, to assess feeding injury. Prior to leaving the field, all roots were labeled with study name and plot number using a permanent marker. Roots were cleaned at the ISU Johnson Farm's root washing station. Roots were first soaked in water for two hours and then washed with a hose to remove any remaining soil. Roots were evaluated August 15, 2018, for rootworm feeding injury following the Iowa State Node Injury Scale (0-3) (Table 1).

Node injury scale (0-3).

- 0.00 - No feeding injury (lowest rating that can be given).
- 1.00 - One node (circle of roots), or the equivalent of an entire node, pruned to within 1.5 in. of the stalk or soil line.
- 2.00 - Two nodes pruned.
- 3.00 - Three or more nodes pruned. (Highest rating that can be given).

Injury between complete nodes pruned was noted as the proportion of the node missing (e.g., 1.50 = one and a half nodes pruned and 0.25 = one quarter of one node pruned).

Yields. This study was machine harvested October 24, 2018, with a modified John Deere 9450 plot combine owned by Iowa State University. Weight (lb) and percent moisture were recorded with a high capacity grain gauge using a HarvestMaster brand harvest data collection system. These measurements were converted to bushels/acre of No. 2 shelled corn (56 lb/bushel) at 15.5 percent moisture in Microsoft Excel (Table 3).

Data. Data on node injury and product consistency were analyzed with analysis of variance (ANOVA) in SAS 9.4. When a significant treatment effect was present, pairwise comparisons were made among means with an experiment-wise error rate of $P < 0.05$.

Product consistency. Percent product consistency was calculated as the percentage of times a treatment limited feeding injury to 0.25 nodes or less (greater injury may result in economic yield loss, especially when plants are moisture stressed).

Results and Discussion

This study had moderate rootworm pressure, with the untreated check suffering slightly over one node of root injury. All of the treatments suffered significantly less root injury than the untreated check, but no significant differences were present among treatments (Table 1). Non-rootworm-Bt corn with soil-applied insecticide did not differ from rootworm treated Bt corn in terms of root injury, and adding soil-applied insecticide to Bt corn did not significantly reduce root injury (Table 1). Product consistency for non-rootworm-Bt corn with insecticide tended to be lower than Bt corn and Bt corn with soil-applied insecticide (Table 1). Some differences in stand counts were detected, but these appeared to be due to difference among hybrids (Table 2). No differences in yield were detected among treatments (Table 3).

Acknowledgements

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Additional Information

Annual reports for the Iowa Evaluation of Insecticides and Plant-Incorporated Protectants are available online through the ISU Department of Entomology:

<http://www.ent.iastate.edu/dept/faculty/gassmann/rootworm>

Table 1. Average root injury and product consistency for insecticide on RW-Bt corn, ISU Johnson Farm, Ames, IA.¹

Treatment ²	Formulation	Rate ³	Placement ⁴	Node-injury ^{5,6,7}	Product consistency ^{7,8}
Dekalb SSTX RIB + Aztec HC	9.34G	1.50	Furrow-SB	0.05a	95a
Pioneer AMXT + Index	2.80CS	0.72	Furrow	0.05a	100a
Pioneer AMX + Aztec HC	9.34G	1.50	Furrow-SB	0.06a	100a
Dekalb SSTX RIB + Index	2.80CS	0.72	Furrow	0.07a	95a
Dekalb SSTX RIB	-----	-----	-----	0.08a	95a
Pioneer AMX + Index	2.80CS	0.72	Furrow	0.09a	100a
Pioneer AMXT + Aztec HC	9.34G	1.50	Furrow-SB	0.10a	95a
Pioneer AMX	-----	-----	-----	0.12a	80ab
Pioneer AMXT	-----	-----	-----	0.20a	85ab
Dekalb non-RW Bt + Index	2.80CS	0.72	Furrow	0.27a	50bc
Dekalb non-RW Bt + Aztec HC	9.34G	1.50	Furrow-SB	0.29a	65ab
Dekalb non-RW Bt	-----	-----	-----	1.11b	15c

¹Planted May 8 and 9, 2018; evaluated August 15, 2018.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P RIB (DeKalb 64-35); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 60-67); Pioneer AMX = Pioneer AcreMax Xtra (PO151AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).

³All insecticides listed as ounces of formulated product/1,000 row feet. Index = fl oz and Aztec HC = oz.

⁴Furrow-SB = insecticide applied in furrow with SmartBox system at planting time; Furrow = insecticide applied in furrow at planting time.

⁵Means based on 20 observations (5 roots/2 rows x 4 replications).

⁶Iowa State Node-Injury scale (0-3). Number of full or partial nodes completely eaten.

⁷Product consistency = percentage of times nodal injury was 0.25 (¼ node eaten) or less.

⁸Significant difference between the treatment means for both node-injury and product consistency (P < 0.05).

Table 2. Average stand count for insecticide on RW-Bt corn, ISU Johnson Farm, Ames, IA.¹

Treatment ²	Formulation	Rate ³	Placement ⁴	Stand counts ^{5,6}
Dekalb SSTX RIB + Index	2.80CS	0.72	Furrow	33.63a
Pioneer AMX + Index	2.80CS	0.72	Furrow	33.50a
Dekalb SSTX RIB + Aztec HC	9.34GR	1.50	Furrow-SB	33.31a
Pioneer AMX	-----	-----	-----	33.19ab
Dekalb SSTX RIB	-----	-----	-----	32.94ab
Dekalb non-RW Bt + Aztec HC	9.34GR	1.50	Furrow-SB	32.88ab
Pioneer AMX + Aztec HC	9.34GR	1.50	Furrow-SB	32.81ab
Dekalb non-RW Bt	-----	-----	-----	32.13abc
Dekalb non-RW Bt + Index	2.80CS	0.72	Furrow	31.69abc
Pioneer AMXT	-----	-----	-----	30.38bc
Pioneer AMXT + Aztec HC	9.34GR	1.50	Furrow-SB	29.94c
Pioneer AMXT + Index	2.80CS	0.72	Furrow	29.50c

¹Planted May 8 and 9, 2018; evaluated June 18 and October 11, 2018.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P RIB (DeKalb 64-35); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 60-67); Pioneer AMX = Pioneer AcreMax Xtra (PO151AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).

³All insecticides listed as ounces of formulated product/1,000 row feet. Index = fl oz and Aztec HC = oz.

⁴Furrow-SB = insecticide applied in furrow with SmartBox system at planting time; Furrow = insecticide applied in furrow at planting time.

⁵Means based on 16 observations (2-row treatment x 17.4 row-ft/treatment x 4 replications x 2 evaluation dates).

⁶Significant differences between means (ANOVA, P < 0.05).

Table 3. Average yield for insecticide on RW-Bt corn, ISU Johnson Farm, Ames, IA.¹

Treatment²	Formulation	Rate³	Placement⁴	Bushels/acre^{5,6,7}
Dekalb non-RW Bt + Aztec HC	9.34GR	1.50	Furrow-SB	257.42
Dekalb SSTX RIB + Index	2.80CS	0.72	Furrow	255.55
Dekalb non-RW Bt + Index	2.80CS	0.72	Furrow	255.05
Dekalb SSTX RIB	-----	-----	-----	250.87
Dekalb SSTX RIB + Aztec HC	9.34GR	1.50	Furrow-SB	249.78
Dekalb non-RW Bt	-----	-----	-----	246.94
Pioneer AMX + Index	2.80CS	0.72	Furrow	241.55
Pioneer AMX + Aztec HC	9.34GR	1.50	Furrow-SB	241.35
Pioneer AMXT + Index	2.80CS	0.72	Furrow	239.75
Pioneer AMXT + Aztec HC	9.34GR	1.50	Furrow-SB	232.97
Pioneer AMX	-----	-----	-----	224.40
Pioneer AMXT	-----	-----	-----	220.43

¹Planted May 8 and 9, 2018; harvested October 24, 2018.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P RIB (DeKalb 64-35); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 60-67); Pioneer AMX = Pioneer AcreMax Xtra (PO151AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).

³All insecticides listed as ounces of formulated product/1,000 row ft. Index = fl oz and Aztec HC = oz.

⁴Furrow-SB = insecticide applied in furrow with SmartBox system at planting time; Furrow = insecticide applied in furrow at planting time.

⁵Means based on 4 observations (4-row treatment x 30 row-ft/treatment x 4 replications).

⁶No significant differences between means (ANOVA, $P \geq 0.05$).

⁷Yields converted to 15.5% moisture.