

Evaluation of Various Management Techniques for Corn Rootworm Larvae

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Introduction

The purpose of this study was to evaluate the effectiveness of non-Bt corn, Bt corn, and soil insecticide, either alone or in combination, for management of larval corn rootworm. Evaluation of corn hybrids included DeKalb non-RW Bt, DeKalb Smartstax RIB, Pioneer Optimum AcreMax Xtreme, and Pioneer Optimum AcreMax1. Soil insecticides evaluated were Aztec-SB 9.34G and Index 2.80 CS.

Materials and Methods

The study was conducted in a field that 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. The study was a randomized complete block design with four replications. Treatments were two rows wide, and 75 ft in length. This study was planted May 4 at a population of 35,600 seeds/acre. Seeds were pre-bagged and planted with a four-row John Deere Max Emerge™ 7100 integral planter that had 30-in. row spacing. This study was planted at a depth of 2 in., with a spacing of 0.6 in. between seeds.

The Aztec-SB 9.34G insecticide treatments were applied with modified SmartBox™ metering units mounted on the planter. These 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 bottle attached to the top provided a secure and sealed container for insecticide for the SmartBox™ units. Clear plastic tubes directed the granular insecticides to the in-furrow placement.

Before the season, two new spray nozzles were installed per row (T-Band and In-Furrow) and calibrated with water to ensure proper application of the product.

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 as ounces/1,000 row ft using Teejet XR80015EVS spray nozzles at 21 psi to deliver 5 GPA of finished spray at a tractor speed of 4 mph. The Index 2.80CS product used water as the carrier.

For these liquid applications, each row was checked for correct spray pattern prior to application and monitored during application to ensure insecticides were applied correctly. Final incorporation was accomplished with drag chains mounted behind the closing wheels.

On May 31, early season stand counts were measured in all treatments. These were measured by laying a stand-count chain 17.5 ft long (1/1,000 of an acre for 30-in. row spacing) between the two corn rows and counting the number of plants in both rows. Late season stand counts were measured on October 13 following the same procedure as

early season stand counts, but using a 2 in. PVC pipe cut to 17.5 ft long. Measurements for both dates were averaged to provide a single value for stand counts (Table 2).

On July 28, five root systems were dug per replication from all treatments for a total of 20 roots per treatment. Prior to leaving the field, excess soil was removed and all roots were labeled with study name and plot number using a permanent marker. Roots were cleaned at the Iowa State University 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 July 31, 2017, for rootworm feeding injury following the Iowa State Node-Injury Scale (0-3) (Table 1).

Node-injury scale (0-3).

- 0.0 No feeding injury (lowest rating that can be given).
- 1.0 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 scored as the percentage of the node missing (e.g., 1.50 = one and a half nodes pruned and 0.25 = one quarter of one node pruned).

Percent product consistency (Table 1) was calculated as 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).

This study was machine harvested October 25 with a modified John Deere 9450 plot combine. Weights (lb) and percent moisture were recorded from Avery-Weigh Tronix load cell bars with an XL900 weigh scale indicator

and a Shivers 5010 Moisture meter data collector. These measurements were converted to bushels/acre of No. 2 shelled corn (56 lb/bushel) at 15.5 percent moisture in Excel (Table 3).

All data were analyzed with standard ANOVA procedures using SAS 9.4. When a significant treatment effect was present, pairwise comparisons were made among means with an experiment-wise error rate of $P < 0.05$.

Results and Discussion

In general, the pressure at this study was light, with the untreated check suffering only less than half a node of injury. All Bt hybrids significantly reduced injury compared with the untreated check. For the Bt hybrids evaluated, the addition of soil-applied insecticide did not significantly reduce root injury. Index, a soil-applied insecticide on non-Bt corn, had a similar level of root injury to the Bt hybrids. It is worth noting all the Bt hybrids evaluated in this study contained the Cry34/35Ab1 trait. Although resistance to Cry3Bb1 corn by western corn rootworm is widespread, resistance to Cry34/35Ab1 appears to be limited in distribution and incomplete, and this likely contributed to the high level of root protection observed for Bt hybrids in this study. Yield was similar among treatments, which was probably due in part to the low level of rootworm pressure in this study. The numerically highest yield was for a non-RW Bt hybrid with soil-applied insecticide.

Acknowledgements

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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 AMVAC Aztec-HC efficacy and yield study: Northeast Research and Demonstration Farm, Nashua.¹

Treatment ²	Form.	Rate ³	Placement ⁴	Node injury ^{5,6,7}	Consistency ^{7,8}
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	0.03a	100a
Pioneer AMXT + Index	2.80CS	0.27	Furrow	0.03a	100a
Pioneer AMXT	-----	-----	-----	0.04a	100a
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	0.04a	100a
DeKalb SSTX RIB	-----	-----	-----	0.05a	100a
Pioneer AMX + Index	2.80CS	0.27	Furrow	0.05a	100a
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	0.05a	95ab
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	0.07a	95ab
Pioneer AMX	-----	-----	-----	0.14a	90ab
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	0.14ab	90ab
DeKalb non-RW Bt	-----	-----	-----	0.31 bc	70ab
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	0.41 c	65 b

¹Planted May 4, 2017; evaluated July 31, 2017.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P (DKC 62-98); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 50-82); Pioneer AMX = Pioneer brand Herculex XTRA (P0157AMX); Pioneer AMXT = Pioneer Optimum AcreMax Extreme (P0339AMXT).

³Insecticide listed as ounces a.i./1,000 row-ft.

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

⁵Chemical and check means 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.

⁷Means sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).

⁸Product consistency = percentage of times nodal injury was 0.25 (1/4 node eaten) or less.

Table 2. Average stand count for AMVAC Aztec-HC efficacy and yield study: Northeast Research and Demonstration Farm, Nashua¹

Treatment ²	Form.	Rate ³	Placement ⁴	Stand counts ^{5,6}
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	33.00a
DeKalb non-RW Bt	-----	-----	-----	32.75a
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	32.50ab
Pioneer AMX	-----	-----	-----	32.50ab
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	32.50ab
DeKalb SSTX RIB	-----	-----	-----	32.25ab
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	31.75abc
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	31.75abc
Pioneer AMX + Index	2.80CS	0.27	Furrow	31.75abc
Pioneer AMXT + Index	2.80CS	0.27	Furrow	29.75 bc
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	29.50 cd
Pioneer AMXT	-----	-----	-----	27.50 d

¹Planted May 4, 2017; evaluated May 31 and October 13, 2017.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P (DKC 62-98); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 50-82); Pioneer AMX = Pioneer brand Herculex XTRA (P0157AMX); Pioneer AMXT = Pioneer Optimum AcreMax Extreme (P0339AMXT).

³Insecticide listed as ounces a.i./1,000 row-ft.

⁴Furrow-SB = Insecticide applied with SmartBox system at planting time.

⁵Chemical and check means based on 16 observations (2 rows/treatment x 17.5 row-ft/treatment x 4 replications x 2 evaluation dates).

⁶Means sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).

Table 3. Average yield for AMVAC Aztec-HC efficacy and yield study: Northeast Research and Demonstration Farm, Nashua.¹

Treatment²	Form.	Rate³	Placement⁴	Bushels/acre^{5,6,7}
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	249a
DeKalb non-RW Bt	-----	-----	-----	242ab
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	228abc
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	222abc
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	222abc
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	220abc
Pioneer AMXT	-----	-----	-----	217abc
Pioneer AMX + Index	2.80CS	0.27	Furrow	212abc
DeKalb SSTX RIB	-----	-----	-----	211abc
Pioneer AMX	-----	-----	-----	210abc
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	206 bc
Pioneer AMXT + Index	2.80CS	0.27	Furrow	203 c

¹Planted May 4, 2017; machine harvested October 25, 2017.

²Non-RW Bt = an absence of any Bt trait targeting corn rootworm; DeKalb non-RW Bt = DeKalb brand VT2P (DKC 62-98); DeKalb SSTX RIB = DeKalb brand Smartstax RIB (DKC 50-82); Pioneer AMX = Pioneer brand Herculex XTRA (P0157AMX); Pioneer AMXT = Pioneer Optimum AcreMax Extreme (P0339AMXT)

³Insecticide listed as ounces a.i. per 1,000 row-ft.

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

⁵Chemical and check means based on four observations (2-row treatment x 68 row-ft/treatment x 4 replications).

⁶Means sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).

⁷Yields converted to 15.5% moisture.