Evaluation of Various Technologies 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 non-Bt corn, Bt corn, and soil insecticide, either alone or in combination, for management of larval corn rootworm. The Bt trait packages evaluated in this study were DeKalb Smartstax RIB, Pioneer AcreMax Xtreme (AMXT), and Pioneer AcreMax Xtra (AMX). Two soil-applied insecticides, Aztec-SB 9.34G and Index 2.80 CS, also were evaluated.

Materials and Methods

Study location. The study was conducted at the Iowa State University Johnson Farm. 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 two rows wide, and 75 ft in length. Plots were cut down to 70 ft in length to facilitate root digging.

Planting. This study was planted May 15, 2017, using a four-row John Deere Max Emerge™ 7100 Integral Rigid Frame Planter with 30-in. row spacing. This 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. The Aztec-HC 9.34G insecticide treatment 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 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.

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 Index 2.80 CS product used water as the carrier.

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 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 5, early season stand counts were measured in all treatments. These were measured by laying a stand-count chain 17.4 ft long (1/1,000 of an acre for 30-in. row spacing) between two rows of corn and

counting the number of plants in both rows. Late season stand counts were measured on October 12 following the same procedure as early season stand counts, but using a 2 in. PVC pipe cut to 17.4 ft long. 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 on corn roots, roots were dug July 28, 2017, 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 July 31, 2017, 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 percentage 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 23 with a modified John Deere 9450 plot combine. Weight (lb) and percent moisture were recorded with 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 Excel (Table 3).

Data. Data on node injury and product consistency were analyzed with 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

Feeding injury was fairly light in this study, with the untreated check only suffering 0.64 nodes of root injury. Both Bt rootworm traits and soil-insecticide applied to non-Bt corn significantly reduced root injury compared with the untreated check. However, the addition of a soil-applied insecticide to a Bt rootworm hybrid did not lead to significant further reduction in root injury.

Similarly, product consistency was significantly higher for either rootworm-traited Bt corn or non-Bt corn with soil-applied insecticide, when compared with the untreated check, but product consistency was not significantly improved by adding soil-applied insecticide to rootworm-traited Bt corn. Some variation in stand counts were noted among treatments.

In general, treatments yielded well in this study, with many treatments exceeding 200 bushels/acre. The untreated check yielded only 165 bushels/acre, illustrating the potential for even modest rootworm injury to reduce yield in some cases. Both non-rootworm Bt corn with soil-applied insecticide and Bt-rootworm traited corn had significantly greater yield than the untreated check.

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Annual reports for the Iowa Evaluation of Insecticides and Plant-Incorporated Protectants are available online at 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: ISU Johnson Farm, Ames.[1]

Treatment[2]	Form.	Rate[3]	Placement[4]	Node injury[5,6,7]	Product consistency[7,8]
Pioneer AMXT + Index	2.80CS	0.27	Furrow	0.07a	100a
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	0.09ab	100a
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	0.10ab	85a
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	0.12ab	95a
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	0.15ab	85a
DeKalb SSTX RIB	-----	-----	-----	0.15ab	90a
Pioneer AMXT	-----	-----	-----	0.16ab	95a
Pioneer AMX + Index	2.80CS	0.27	Furrow	0.16ab	85a
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	0.23ab	70a
Pioneer AMX	-----	-----	-----	0.32 b	60ab
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	0.37ab	75a
DeKalb non-RW Bt	-----	-----	-----	0.64 c	40 b

[1]Planted May 15, 2017; evaluated July 31, 2017.

[2]Non-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 AcreMax Xtra (P0157AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).

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

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

[5]Chemical and check means based on 20 observations (5 roots/2 rows x 4 replications).

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

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

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

Table 2. Average stand count for AMVAC Aztec-HC efficacy and yield study: ISU Johnson Farm, Ames.[1]

Treatment[2]	Form.	Rate[3]	Placement[4]	Stand counts[5,6]
DeKalb SSTX RIB	-----	-----	-----	32.75a
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	32.50a
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	32.25a
DeKalb non-RW Bt	-----	-----	-----	31.50a
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	31.50a
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	31.50a
Pioneer AMX	-----	-----	-----	31.50a
Pioneer AMX + Index	2.80CS	0.27	Furrow	31.25a
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	30.75ab
Pioneer AMXT + Index	2.80CS	0.27	Furrow	30.25ab
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	29.00 b
Pioneer AMXT	-----	-----	-----	28.75 b

[1]Planted May 15, 2017; evaluated June 5 and October 12, 2017.
[2]Non-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 AcreMax Xtra (P0157AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).
[3]Insecticide listed as ounces a.i./1,000 row-ft.
[4]Furrow-SB = insecticide applied with SmartBox system at planting time; Furrow = insecticide applied at planting time.
[5]Chemical and check means based on 16 observations (2 rows/treatment x 17.4 row-ft/treatment x 4 replications x 2 evaluation dates).
[6]Means 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: ISU Johnson Farm, Ames.[1]

Treatment[2]	Form.	Rate[3]	Placement[4]	Bushels/acre[5,6,7]
Pioneer AMXT + Index	2.80CS	0.27	Furrow	230a
DeKalb non-RW Bt + Index	2.80CS	0.27	Furrow	222ab
Pioneer AMX + Index	2.80CS	0.27	Furrow	212ab
Pioneer AMXT	-----	-----	-----	212ab
Pioneer AMXT + Aztec-HC	9.34G	0.14	Furrow-SB	208abc
Pioneer AMX	-----	-----	-----	205abc
Pioneer AMX + Aztec-HC	9.34G	0.14	Furrow-SB	199abc
DeKalb non-RW Bt + Aztec-HC	9.34G	0.14	Furrow-SB	199abc
DeKalb SSTX RIB + Index	2.80CS	0.27	Furrow	186abc
DeKalb SSTX RIB + Aztec-HC	9.34G	0.14	Furrow-SB	185abc
DeKalb SSTX RIB	-----	-----	-----	180 bc
DeKalb non-RW Bt	-----	-----	-----	165 c

[1]Planted May 15, 2017; machine harvested October 23, 2017.
[2]Non-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 AcreMax Xtra (P0157AMX); Pioneer AMXT = Pioneer AcreMax Xtreme (P0339AMXT).
[3]Insecticide listed as ounces a.i./1,000 row-ft.
[4] Furrow-SB = insecticide applied with SmartBox system at planting time; Furrow = insecticide applied at planting time.
[5]Chemical and check means based on 4 observations (2-row treatment x 68 row-ft/treatment x 4 replications).
[6]Means sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).
[7]Yields converted to 15.5% moisture.