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 Syngenta Duracade. One soil-applied insecticide, Aztec HC, also was evaluated.

Materials and Methods

Study location. The study was conducted at the Iowa State University (ISU) 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 four rows wide, and 35 ft in length. Plots were cut to 30 ft in length after planting.

Planting. This study was planted April 29, 2020, 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 in-furrow 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 1 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. 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 May 29, 2020, early season stand counts were measured in all treatments. These were measured by using a 2-in. PVC pipe cut to 17.4 ft long (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 then counted. Late-season stand counts were measured September 22, 2020, 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 on corn roots, roots were dug July 20, 2020, to assess feeding injury. Prior to leaving the field, all roots were labeled with study name and plot number. Roots were cleaned at the ISU Johnson Farm's root washing station. Roots were first soaked in water for 2-8 hours, then washed with a hose to remove any remaining soil. Roots were evaluated July 21, 2020, 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 in 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).

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).

Yields. This study was machine harvested October 16, 2020, 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 HarvestMaster brand harvest data collection system. These measurements were converted to bushel/acre of No. 2 shelled corn (56 lb/bushel) at 15.5 percent moisture (Table 3).

Data analysis. Data were analyzed with analysis of variance (ANOVA) in SAS Enterprise Guide 7.1. The treatment means were compared using LSMEAN procedure with an experimentwise error rate of $P < 0.05$.

Results and Discussion

Root injury in this study was fairly low, with the untreated check (Pioneer AM without insecticide) suffering only 0.46 nodes of injury (Table 1). When soil-applied insecticide (Aztec HC) was added to non-rootworm-Bt corn (Pioneer AM), a significant reduction in root injury was observed. However, for all treatments where soil insecticide was added to a rootworm-traited Bt hybrid (Smartstax, Duracade, or AcreMax Xtreme), no significant reductions in root injury were detected (Table 1). These results suggest that while soil-applied insecticide is useful for reducing rootworm feeding injury for corn that lacks a rootworm active Bt trait, there is minimal, if any, benefit to adding soil-applied insecticide to a rootworm-traited hybrid. Furthermore, past research has found that in cases where a Bt hybrid is compromised by rootworm resistance, the best option is to use a non-rootworm-Bt hybrid with soil-applied insecticide.

Patterns of product consistency were similar to data on root injury, with the untreated check showing significantly lower product consistency than all other treatments (Table 1). However, no significant differences among treatments were detected (Table 1).

Stand counts were similar among treatments, although some significant differences were detected (Table 2). Differences were present in yield, however, all of these differences appeared to be associated with individual hybrids (Table 3). Therefore, some hybrid genetics were a better match for this study location than others, which generated differences in yield. In no cases was a significant increase in yield observed when soil insecticide was added to a hybrid. This was likely because of the low level of rootworm feeding injury observed in this study. At higher levels of feeding injury, the significant reduction in root injury achieved by soil-applied insecticide or rootworm-active Bt traits would be expected to lead to an increase in yield.

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, Story Co.[a]

Treatment[b]	Formulation	Rate[c]	Placement[d]	Node-injury[e,f,g]	Product consistency[h]
Dekalb SSTX RIB	-----	-----	----------	0.03a	100a
Dekalb SSTX RIB + Aztec HC	9.34G	1.50	Furrow-SB	0.05a	100a
Pioneer AMXT + Aztec HC	9.34G	1.50	Furrow-SB	0.07a	100a
Syngenta Duracade +Aztec HC	9.34G	1.50	Furrow-SB	0.07a	90a
Pioneer AMXT	-----	-----	----------	0.08a	90a
Pioneer AM + Aztec HC	9.34G	1.50	Furrow-SB	0.12a	85a
Syngenta Duracade	-----	-----	----------	0.14a	90a
Pioneer AM	-----	-----	----------	0.46b	50b

[a]Planted April 29, 2020; evaluated July 21, 2020.
[b]Non-RW Bt = an absence of any Bt trait targeting corn rootworm; Pioneer non-RW Bt= Pioneer AcreMax (P1151 AM); DeKalb SSTX RIB = Dekalb brand Smartstax RIB (DKC 62-52); Pioneer AMXT = Pioneer AcreMax Xtreme (P1197 AMXT); Syngenta Duracade = (G12W66-5222-EZ1).
[c]All insecticides listed as ounces/1,000 row ft.
[d]Furrow-SB = insecticide applied in furrow with SmartBox system at planting time.
[e]Means based on 20 observations (5 roots/2 rows x 4 replications).
[f]Iowa State Node-Injury scale (0-3). Number of full or partial nodes completely eaten.
[g]Product consistency = percentage of times nodal injury was 0.25 (¼ node eaten) or less.
[h]Significant difference between the treatment means for both node-injury and product consistency (ANOVA, $P < 0.05$).

Table 2. Average stand count for insecticide on RW-Bt Corn. ISU Johnson Farm, Story Co.[a]

Treatment[b]	Formulation	Rate[c]	Placement[d]	Stand counts[e,f]
Syngenta Duracade	-----	-----	----------	32.4a
Dekalb SSTX RIB	-----	-----	----------	32.1ab
Dekalb SSTX RIB + Aztec HC	9.34GR	1.50	Furrow-SB	32.1ab
Pioneer AMXT + Aztec HC	9.34GR	1.50	Furrow-SB	31.4ab
Pioneer AM	-----	-----	----------	31.3ab
Pioneer AMXT	-----	-----	----------	31.1ab
Pioneer AM + Aztec HC	9.34GR	1.50	Furrow-SB	30.4ab
Syngenta Duracade + Aztec HC	9.34GR	1.50	Furrow-SB	29.1b

[a]Planted April 29, 2020; evaluated May 29 and September 22, 2020.
[b]Non-RW Bt = an absence of any Bt trait targeting corn rootworm; Pioneer non-RW Bt= Pioneer AcreMax (P1151 AM); DeKalb SSTX RIB = Dekalb brand Smartstax RIB (DKC 62-52); Pioneer AMXT = Pioneer AcreMax Xtreme (P1197 AMXT); Syngenta Duracade = (G12W66-5222-EZ1).
[c]All insecticides listed as ounces/,1000 row ft.
[d]Furrow-SB = insecticide applied in furrow with SmartBox system at planting time.
[e]Data presented as plants per 1/1000 of an acre.
[f]Significant differences between means (ANOVA, $P < 0.05$).

Table 3. Average yield for insecticide on RW-Bt corn. ISU Johnson Farm, Story Co.[a]

Treatment[b]	Formulation	Rate[c]	Placement[d]	Bushels/acre[e,f,g]
Pioneer AMXT	-----	-----	----------	224.4a
Pioneer AMXT + Aztec HC	9.34GR	1.50	Furrow-SB	218.5a
Dekalb SSTX + Aztec HC	9.34GR	1.50	Furrow-SB	209.5ab
Dekalb SSTX	-----	-----	----------	200.7abc
Pioneer AM	-----	-----	----------	190.5bcd
Pioneer AM + Aztec HC	9.34GR	1.50	Furrow-SB	186.5bcd
Syngenta Duracade + Aztec HC	9.34GR	1.50	Furrow-SB	183.5cd
Syngenta Duracade	-----	-----	----------	175.1d

[a]Planted April 29, 2020; harvested October 16, 2020.

[b]Non-RW Bt = an absence of any Bt trait targeting corn rootworm; Pioneer non-RW Bt= Pioneer AcreMax (P1151 AM); DeKalb SSTX RIB = Dekalb brand Smartstax RIB (DKC 62-52); Pioneer AMXT = Pioneer AcreMax Xtreme (P1197 AMXT); Syngenta Duracade = (G12W66-5222-EZ1).

[c]All insecticides listed as ounces/1,000 row ft.

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

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

[f]Significant differences between means (ANOVA, $P < 0.05$).

[g]Yields reported at 15.5% moisture.