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Evaluation of Bt and Non-Bt Corn with and without Soil Insecticides for Control of Corn Rootworm

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Abstract
The purpose of this study was to evaluate the effectiveness of Bt corn and soil insecticides, either alone or in combination, for the control of corn rootworm. Evaluation of Bt hybrids included SmartStax, SmartStax with refuge in a bag, and Herculex XTRA. Soil insecticides evaluated were SmartChoice-SB, Counter-SB, Aztec, and Force.

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Evaluation of Bt and Non-Bt Corn with and without Soil Insecticides for Control of Corn Rootworm

RFR-A1185

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Introduction

The purpose of this study was to evaluate the effectiveness of Bt corn and soil insecticides, either alone or in combination, for the control of corn rootworm. Evaluation of Bt hybrids included SmartStax, SmartStax with refuge in a bag, and Herculex XTRA. Soil insecticides evaluated were SmartChoice-SB, Counter-SB, Aztec, and Force.

Materials and Methods

The corn was planted in an area that had been planted the previous year with "trap crop." The seed planted for the trap crop was a mixed maturity blend with a greater proportion of late-maturing varieties. This trap crop constitutes a favorable environment for adult females late in the season when other fields are maturing and results in a high abundance of rootworm larvae the following year. The experimental design for this study was a randomized complete block design with four replications. Treatments were two rows wide, and 75 feet in length. This study was planted on May 5 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.

Aztec 2.1G granular insecticide was applied to two treatments 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 the seed furrow, placing all the insecticide in-furrow (Furrow). Eleven-inch poly-bristle skirts were attached to the frame and positioned so the bristle tips touched the ground. Each row was constantly monitored to ensure that insecticides were applied correctly. Final incorporation was accomplished with drag chains mounted behind the closing wheels. The SmartChoice-SB 5G and Counter-SB 20G insecticide treatments were applied with modified SmartBox™ metering units mounted on the planter. The commercial SmartBox™ 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 L bottle attached to the top provided a secure and sealed container for insecticide. A short plastic tube attached to the dispenser of the metering unit was connected to the planter's furrow tubes.

On August 9, five root systems were dug per replication from all treatments except SmartStax with a blended refuge in which we sampled nine root systems (6 Smartstax + 3 Non-Bt). Prior to leaving the field, excess soil was removed and all roots were labeled with study name, plot number, and row using a permanent marker. Roots were transported to the Insectary Building at Iowa State University where they were soaked in water and then washed with a pressurized hose to remove any remaining soil. On August 11, roots were evaluated for rootworm feeding injury following the Iowa State Node-Injury Scale (0–3).

The study was machine harvested on October 7 with a modified John Deere 9410 plot combine. Weights (pounds) and percent moisture were recorded from a HarvestMaster brand plot harvest data collection system. These measurements were converted to bushels per acre of No. 2 shelled corn (56 lb/bushel) at 15 percent moisture.

Results and Discussion

Node injury was significantly higher for the two non-Bt isoline treatments (checks) and lowest for Mycogen Herculex XTRA with SmartChoice-SB insecticide. Injury also was similar among DeKalb Smartstax with Aztec 2.1G, Mycogen Herculex XTRA with Force 3G, and Mycogen SmartStax (Table 1). Stand counts were similar among treatments, although the Mycogen isoline hybrid had a lower stand count than SmartStax with a blended refuge (Table 2). For yield, the Mycogen isoline hybrid (untreated check) was lower than Mycogen Herculex XTRA with either Force 3G or SmartChoice 5G (Table 3).

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Additional Information

Annual reports for the Iowa Evaluation of Insecticides and Plant-Incorporated Protectants are available through the Iowa State University Department of Entomology http://www.ent.iastate.edu/.

Table 1. Average root-injury and percent product consistency for evaluation of insecticide treatments and plant-incorporated protectants.[1]

Treatment[2,3]	Form.	Rate[4]	Placement[5]	Node-injury[6,7,8]	Product consistency[9,10]
My-HXX + SmartChoice-SB	5G	0.18	In-Furrow	0.09a	90a
DeKalb-SmartSTAX + Aztec	2.1G	0.14	In-Furrow	0.18ab	75ab
My-HXX + Force	3.0G	0.12	In-Furrow	0.24 bc	60ab
My-SmartSTAX	------	-----	-----	0.28 bc	65ab
My-HXX + Counter-SB	20G	0.90	In-Furrow	0.44 cd	45abc
My-HXX	------	-----	-----	0.51 d	25abc
My-Iso + Force	3.0G	0.12	In-Furrow	0.56 de	25 bc
DeKalb-Iso + Aztec	2.1G	0.14	In-Furrow	0.77 de	15 bc
My-95%SSTX/5%Non-Bt[11]	------	-----	-----	0.99 e	8 bc
DeKalb-Iso	------	-----	-----	1.54 f	0 c
My-Iso	------	-----	-----	2.27 g	0 c

[1]Planted May 5, 2011; evaluated August 11, 2011.
[2]My-SmartSTAX = Mycogen Smartstax (Mycogen 2K594); My-HXX = Mycogen brand Herculex XTRA (Mycogen 2K592); DeKalb-SmartSTAX = DeKalb Smartstax (DKC61-21); DeKalb-Iso = DeKalb brand RR Isoline (DKC 61-72); My-Iso = Mycogen brand RR2 (Mycogen 2K591); My-95%SSTX/5%Non-Bt = Mycogen 95% Smartstax + 5% Non-Bt (Refuge in a Bag) (Mycogen 2K594+ Mycogen 2K591).
[3]My-Iso (Mycogen 2K591) is the isoline of My-HXX (Mycogen 2K592).
[4]Insecticide listed as ounces a.i. per 1,000 row-feet.
[5]In-Furrow = insecticide applied at planting time; SB = SmartBox application at planting time.
[6]Chemical and check means (except My-95%SSTX/5%Non-Bt treatment) based on 20 observations (5 roots/2 rows × 4 replications).
[7]Iowa State Node-Injury scale (0–3). Number of full or partial nodes completely eaten.
[8]Means within a column sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).
[9]Product consistency = Percentage of times nodal injury was 0.25 (¼ node eaten) or less.
[10]Means within a column sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).
[11]For the SmartStax with a blended refuge treatment (My-95%SSTX/5% Non-Bt), mean based on 36 observations (9 roots/2 rows (6 Smartstax (3 adjacent roots and 3 distant roots to a Non-Bt plant) + 3 Non-Bt) × 4 replications).

Table 2. Average stand counts for evaluation of insecticide treatments and plant-incorporated protectants.[1]

Treatment[2,3]	Form.	Rate[4]	Placement[5]	Stand count[6,7]
My-95%SSTX/5%Non-Bt	------	-----	-----	36.00a
My-HXX + SmartChoice-SB	5G	0.18	In-Furrow	35.25ab
My-SmartSTAX	------	-----	-----	35.25ab
DeKalb-Iso	------	-----	-----	34.50ab
DeKalb-SmartSTAX + Aztec	2.1G	0.14	In-Furrow	34.50ab
My-HXX + Force	3.0G	0.12	In-Furrow	34.50ab
My-Iso + Force	3.0G	0.12	In-Furrow	34.25ab
My-HXX	------	-----	-----	34.00ab
DeKalb-Iso + Aztec	2.1G	0.14	In-Furrow	33.75ab
My-HXX + Counter-SB	20G	0.90	In-Furrow	33.50 b
My-Iso	------	-----	-----	33.50 b

[1]Planted May 5, 2011; evaluated June 8 and September 30, 2011.
[2]My-SmartSTAX = Mycogen Smartstax (Mycogen 2K594); My-HXX = Mycogen brand Herculex XTRA (Mycogen 2K592); DeKalb-SmartSTAX = DeKalb Smartstax (DKC61-21); DeKalb-Iso = DeKalb brand RR Isoline (DKC 61-72); My-Iso = Mycogen brand RR2 (Mycogen 2K591); My-95%SSTX/5%Non-Bt = Mycogen 95% Smartstax + 5% Non-Bt (Refuge in a Bag) (Mycogen 2K594+ Mycogen 2K591).
[3]My-Iso (Mycogen 2K591) is the isoline of My-HXX (Mycogen 2K592).
[4]Insecticide listed as ounces a.i. per 1,000 row-feet.
[5]In-Furrow = insecticide applied at planting time; SB = SmartBox application at planting time.
[6]Means based on 16 observations (2-row treatment × 17.5 row-feet/treatment × 4 replications × 2 evaluation dates).
[7]Means within a column sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).

Table 3. Average yield for evaluation of insecticide treatments and plant-incorporated protectants.[1]

Treatment[2,3]	Form.	Rate[4]	Placement[5]	Bushels/acre[6,7,8]
My-HXX + SmartChoice-SB	5G	0.18	In-Furrow	155a
My-HXX + Force	3.0G	0.12	In-Furrow	152a
My-HXX + Counter-SB	20G	0.90	In-Furrow	142ab
My-95%SSTX/5%Non-Bt	------	-----	-----	142ab
My-SmartSTAX	------	-----	-----	141ab
DeKalb-Iso + Aztec	2.1G	0.14	In-Furrow	139ab
My-HXX	------	-----	-----	139ab
DeKalb-Iso	------	-----	-----	128ab
DeKalb-SmartSTAX + Aztec	2.1G	0.14	In-Furrow	119ab
My-Iso + Force	3.0G	0.12	In-Furrow	118ab
My-Iso	------	-----	-----	111 b

[1]Planted May 5, 2011; machine harvested October 7, 2011.
[2]My-SmartSTAX = Mycogen Smartstax (Mycogen 2K594); My-HXX = Mycogen brand Herculex XTRA (Mycogen 2K592); DeKalb-SmartSTAX = DeKalb Smartstax (DKC61-21); DeKalb-Iso = DeKalb brand RR Isoline (DKC 61-72); My-Iso = Mycogen brand RR2 (Mycogen 2K591); My-95%SSTX/5%Non-Bt = Mycogen 95% Smartstax + 5% Non-Bt (Refuge in a Bag) (Mycogen 2K594+ Mycogen 2K591).
[3]My-Iso (Mycogen 2K591) is the isoline of My-HXX (Mycogen 2K592).
[4]Insecticide listed as ounces a.i. per 1,000 row-feet.
[5]In-Furrow = insecticide applied at planting time; SB = SmartBox application at planting time.
[6]Means based on 4 observations (2-row treatment × 69 row-feet/treatment × 4 replications).
[7]Means within a column sharing a common letter do not differ significantly according to Ryan's Q Test ($P \leq 0.05$).
[8]Yields converted to15% moisture.