



## SW MN IPM RESEARCH - 2020

**STUDY:** 2020 Corn rootworm insecticide on trait

### INVESTIGATOR:

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### OBJECTIVE:

Evaluate the potential benefit of layering an insecticides on corn hybrids without and with Bt rootworm traits.

### SUMMARY OF RESULTS:

This study compared the effect of layering an insecticide (Aztec HC @ 1.5 oz/1000 row foot) on four corn hybrids with the following corn rootworm Bt (RW-Bt) proteins: Optimum® AcreMax® (No RW Bt), Optimum® AcreMax Xtreme® (mCry3a + Cry 34/35 Ab1), SmartStax® RIB Complete® (Cry3Bb1 + Cry 34/35 Ab1), Agrisure Duracade® 5122 E-Z® (mCry3a + eCry3.1Ab).

All Hybrids included the minimal commercially available seed applied insecticide. None of these rates should have a large effect on rootworm control. Because the base hybrid genetics and seed applied insecticides are not the same, comparisons between hybrids are somewhat biased but would reflect field performance.

Corn stands, root lodging, root damage based on a 0-3 node injury score (NIS), consistency of control, and corn yields were assessed.

- Severe root injury and resultant lodging from western corn rootworm larvae feeding occurred in the study area.
- Significant differences in corn stand were not observed among treatments.
- Crop injury associated with the in-furrow insecticide was not observed within any hybrid.
- There was a trend for the addition of an in-furrow insecticide to reduced root injury in all hybrids, significantly so ( $\alpha=0.05$ ) in the Agrisure Duracade hybrid.
- Yields were most highly correlated ( $p= 0.0001$ ) with plant population, hybrid and control consistency.

### CROP INFORMATION

**Crop:** Corn (*Zea mays*)

**Cultivar:** Four commercial hybrids with varying BT-RW proteins

**Crop rotation history:** 2016: Corn      2017: Corn      2018: Corn      2019: Corn

### SITE INFORMATION

**Location:** University of Minnesota Southwest Research and Outreach Center near Lamberton, Redwood County, Minnesota.

The study site has been in a continuous corn rotation for several years and managed for corn rootworm research. It has a history of high western corn rootworm populations and resistance to Cry3Bb1. Few northern corn rootworms were observed in this site.

Rainfall was normal early in the season and above normal after insecticide application (**Figure 1**). Additional weather data can be obtained at <https://swroc.cfans.umn.edu/weather>.

#### **Soil fertility (2018 sample):**

**Name:** Amiret and Swan Lake loams

#### **Soil test values (Fall 2018)**

**% OM:** 4.7      **pH:** 6.0

**P (bray):** 21 ppm      **K:** 104 ppm      **Zn:** 1.0 ppm

#### **PLANTING INFORMATION**

**Planting Date:** 04/30/20

**Planting Equipment:** Kinze (Williamsburg, IA) Model 3110 6-row vacuum planter. John Deere 7000 4 row vacuum planter with Precision Planting V-Set meters.

**Row Spacing:** 30-inch      **Seeding Rate:** 34,000 seeds/acre      **Seeding Depth:** 2.0 inch

**Soil Temperature:** 54° F      **Soil Moisture:** Normal

**Precipitation:** Above-average growing season precipitation early and again late season. Slightly above average growing degree-days.

#### **SITE MAINTENANCE**

**Tillage fall 2019:** Disc Ripper      **Tillage Spring 2020:** Field cultivator

**PRE Herbicide:** 04/20/20      Harness– 2.6 pt. / A

**POST Herbicide:** 06/12/20      Cornerstone Plus – 40 fl. oz. / A + Callisto 3.0 fl. oz. / A

**Insecticide application:** In-furrow Aztec granules applied with a SmartBox applicator (AMVAC).

#### **HARVEST INFORMATION**

**Harvest equipment:** The center two rows of each plot were harvested 10/15/20 with an ALMACO (Nevada, IA) plot combine.

#### **EXPERIMENTAL DESIGN**

**Study Design:** Randomized Block

**Treated Plot Width:** 10 foot (four 30-inch rows)

**Treated Plot Length:** 30 foot

**Treatments:** 8

#### **TREATMENTS EVALUATED**

Four corn hybrids, differing in Bt-RW traits (**Table 1**), were planted with and without in-furrow Aztec® HC insecticide at 1.5 oz. product/1000 foot of row. The lowest rate seed-applied insecticide commercially available for each hybrid was included. The resultant eight treatments are shown in **Table 2**. The plots were planted on 4/30/20 with a modified vacuum planter.

	Bt-RW trait package Protein		Seed insecticide applied
Pioneer 0157 AM	Bt refuge		
Pioneer 0157 AMXT	AcreMax Xtreme	<i>mCry3A + Cr34/35Ab1</i>	clothianidin (0.25) + chlorantraniliprole
DeKalb DKC 51-91	SmartStax RIB	<i>Cry3Bb1+ Cry 34/35 Ab1</i>	clothianidin (0.50)
NK 0243-5122.0-EZ1	Agrisure Duracade	<i>mCry3A + eCry3.1Ab</i>	thiamethoxam (.25)

**Table 1.** Hybrids and RW-Bt traits evaluated.

## ASSESSMENT METHODS

On May 28, V2 growth stage corn stands were assessed by counting emerged plants within the thirty-foot lengths of rows two and three.

On July 13, tassel stage corn was similarly rated. Above-ground symptoms of corn rootworm damage to root systems were visible at that time. Lodged plants were counted and the percentage of lodged plants calculated.

Root feeding and lodging was severe in portions of this study. Six randomly selected VT-R1 stage plants were dug from each plot on July 23. The roots were soaked in water overnight and power washed and rated the following day. Five representative roots were selected and dissected. To determine the 0-3 node injury score (NIS), the number of roots and number of roots pruned within 1.5 inches of the stalk were counted for each node. Additionally, a control consistency score was calculated based on the percentage of the five sampled roots where the NIS was below 0.25. The percentage of the five roots sampled that displayed root lodging was calculated.

Continued severe root lodging prevented any further assessments of plots until harvest. On October 15, a plot combine was used to obtain yields from the center two rows of each plot. Yields were adjusted to 56 pounds/ bushel and 15.5% moisture.

## RESULTS

Sample results and statistics are presented in **Table 2**. Some of these data did not meet the assumptions for analysis of variance. As a result, their significance was based on Kruskal-Wallis non-parametric one-way analysis of variance with a parametric analysis applied to the resulting ranks. Subsequent mean separations were based on Dunn's ( $p=0.05$ ).

**Corn stand and health:** At the V2 stage, corn stands were similar and averaged 28,092 emerged plants/acre. Individual plant emergence was highly variable.

At tassel, stands averaged 32,675 and no differences among treatments were detected. Severe lodging reduced the ability to obtain accurate stand counts. The unusually high populations were due to a planter issue at one end of a single plot. It did not affect the other ratings.

### **Efficacy against corn rootworm:**

The effect of hybrid (Bt-RW protein) and layered insecticide are shown in **Figure 2**. The refuge hybrid and the Agrisure Duracade hybrid had the highest NIS, 1.9 and 1.7 respectively. Numerically, the addition of insecticide reduced root injury for all hybrids but this difference was only significant for the

Agrisure Duracade hybrid ( $\alpha = 0.5$ ). The amounts of root injury and lodging for Agrisure Duracade was not surprising because the study field has had failures with Cry 3Bb1 and cross resistance to eCry3.1Ab1 and mCry3a proteins has been documented. Although insecticide reduced root injury on the refuge hybrid, the NIS was still 0.5 or the equivalent of  $\frac{1}{2}$  of a node pruned to 1.5 inches or less in length.

The refuge hybrid without insecticide had the most lodging, while the same hybrid with insecticide and the AcreMax Xtreme hybrid with insecticide, the least. Numerically, the addition of insecticide reduced lodging for all hybrids (**Figure 3**). Lodging percentages calculated from the five plants dissected for root injury were similar.

The addition of insecticide kept the NIS below 0.25 one hundred percent of the time for the SmartStax RIB hybrid. The addition of insecticide maintained the NIS below that level for the Agrisure Duracade and refuge hybrids on eighty and forty percent of the rated roots, respectively.

**Yield:** Treatment yields ranged from 144 to 196 bushels/acre (**Figure 4**). Although the addition of an insecticide produced numerically higher yields in all four hybrids, these intra-hybrid differences were not significant ( $\alpha = 0.05$ ). Yields of some individual plots were likely affected by both physiological losses and harvestability issues caused by lodging. These yields suggest that western corn rootworm may have impacted all four hybrids.

An analysis of variance for the factors hybrid and insecticide overlay showed hybrid significantly ( $\alpha = 0.05$ ) affected both yield and NIS. Insecticide overlay also affected NIS and there was not a hybrid X insecticide interaction. The yield response to insecticide across hybrids indicates the possibility of rootworm impacts on trait pyramids.

## **ACKNOWLEDGEMENTS**

Noah Stavnes, Meriah Kirshtein and Kennedi Janssen provided valuable help in plot maintenance and sampling and processing corn roots for rootworm assessments.

We appreciate the support of AMVAC for this study.

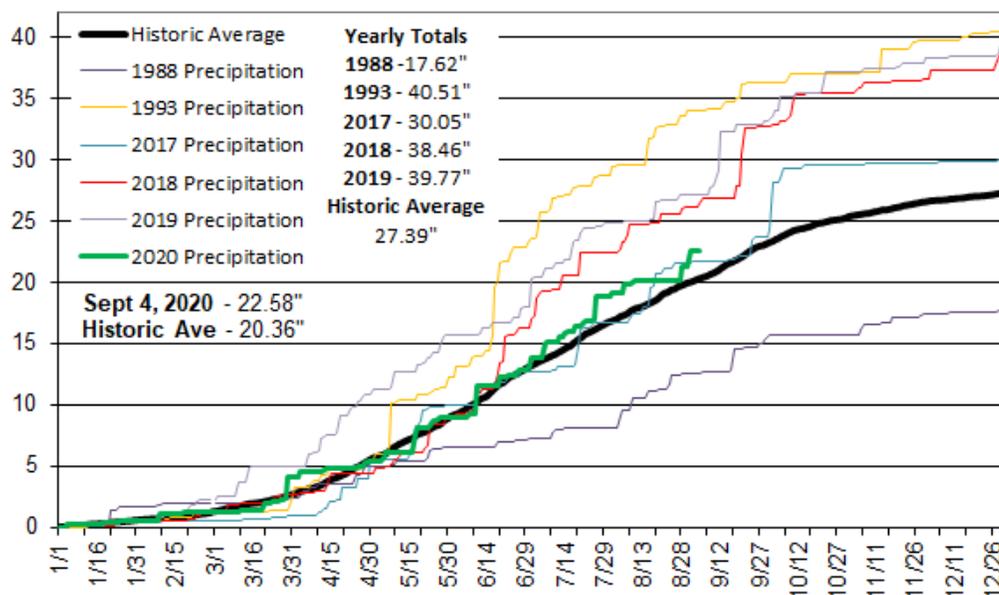
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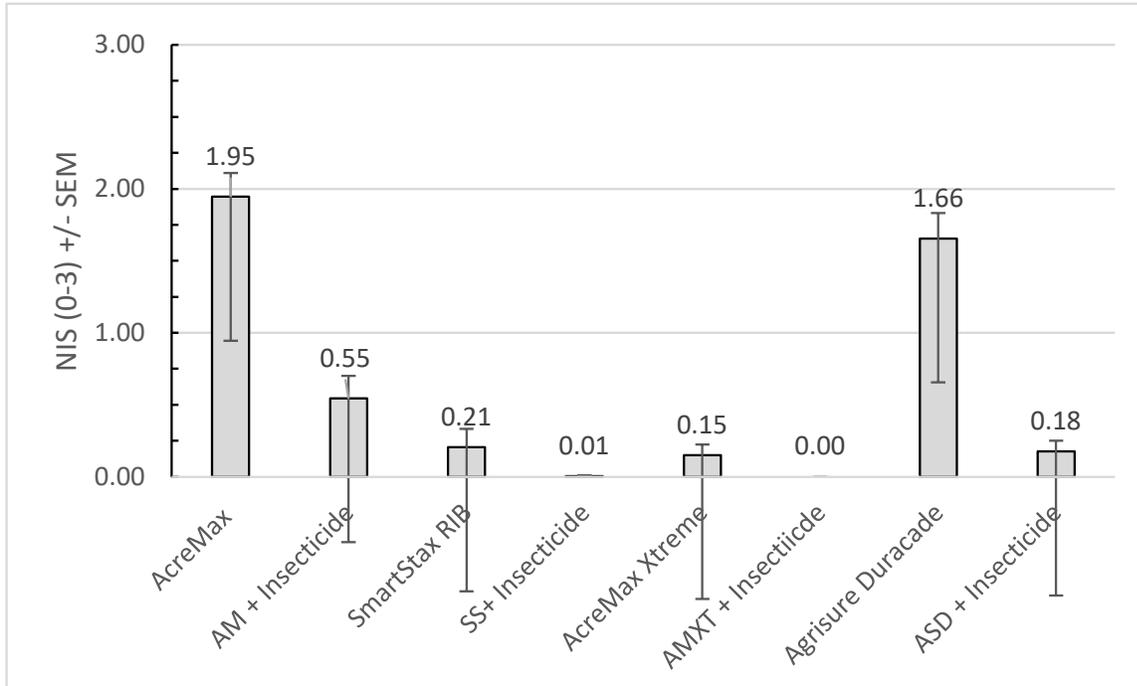
**Figure 1.** 1988, 1993, and 2016 – 2020 Yearly Totals vs. Historic Average (1961 - 2019).  
 See also: <https://swroc.cfans.umn.edu/weather>.

Rating Date	Stand plants/acre	Stand plants/acre	Lodging % plants	Root injury 0-3 NIS	Consistency %	Lodging %	Yield Bu./acre
Crop Stage	5/28/20	7/15/20	7/13/20	7/29/20	7/29/20	7/29/20	10/15/20
Treatment <sup>ψ</sup>	V2	VT	VT	R1	R1	R1	R6
1 No insecticide Refuge hybrid (PIO 0157 AM)	28165 -	33029 -	50.8 a	1.9 a	5 c	75 a	156.0 bc
2 Aztec HC Refuge hybrid (PIO 0157 AM)	32738 -	36150 -	9.7 b	0.5 ab	40 bc	10 ab	180.0 abc
3 No insecticide SmartStax RIB (DKC 51-91)	27512 -	33464 -	12.0 ab	0.2 bc	90 ab	0 b	192.9 ab
4 Aztec HC SmartStax RIB (DKC 51-91)	26278 -	33174 -	11.9 ab	0.0 c	100 a	0 b	195.7 a
5 No insecticide AcreMax Xtreme (PIO 0157 AMXT)	29036 -	32375 -	14.7 ab	0.1 bc	80 ab	10 ab	178.0 abc
6 Aztec HC AcreMax Xtreme (PIO 0157 AMXT)	25697 -	30125 -	9.7 b	0.0 c	100 a	5 ab	181.3 abc
7 No insecticide Agrisure Duracade (NK 0243-5122.0-EZ1)	28601 -	32738 -	24.2 ab	1.7 a	15 c	35 ab	144.2 c
8 Aztec HC Agrisure Duracade (NK 0243-5122.0-EZ1)	26713 -	30343 -	12.2 ab	0.2 b	80 ab	0 b	146.5 c
Standard Deviation	5236.46	4388.30	14.47	0.31	22.73	16.99	15.70
CV	18.64	13.43	79.79	52.56	35.66	100.69	9.14
Treatment Prob(F)	0.2253 *	0.5431 *	0.0008 *	< 0.0001 *	0.0001	0.0002 *	0.0003

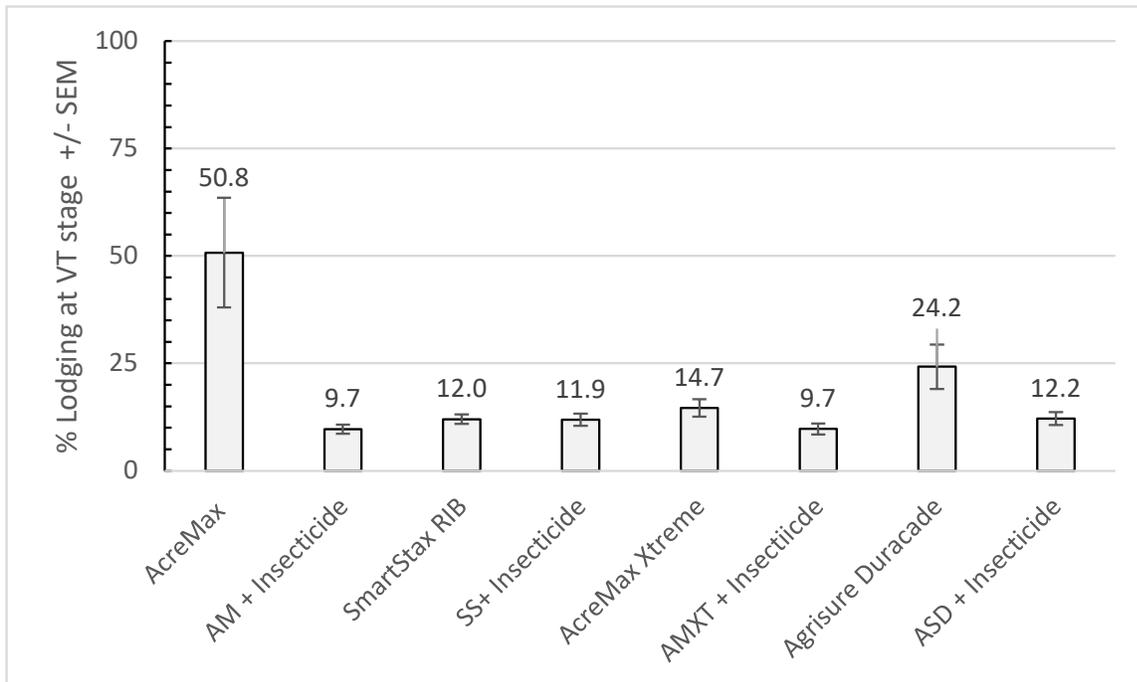
\* data do not meet assumptions for AOV, Significance based on Kruskal-Wallis non-parametric one-way analysis of variance w/ Dunn's all- pairwise comparisons  
 Means followed by same letter or symbol do not significantly differ (P=.05, Tukey's HSD).  
 Mean comparisons performed only when AOV Treatment P(F) is significant

<sup>ψ</sup> Aztec HC applied at 1.5 oz/1000 row feet in-furrow

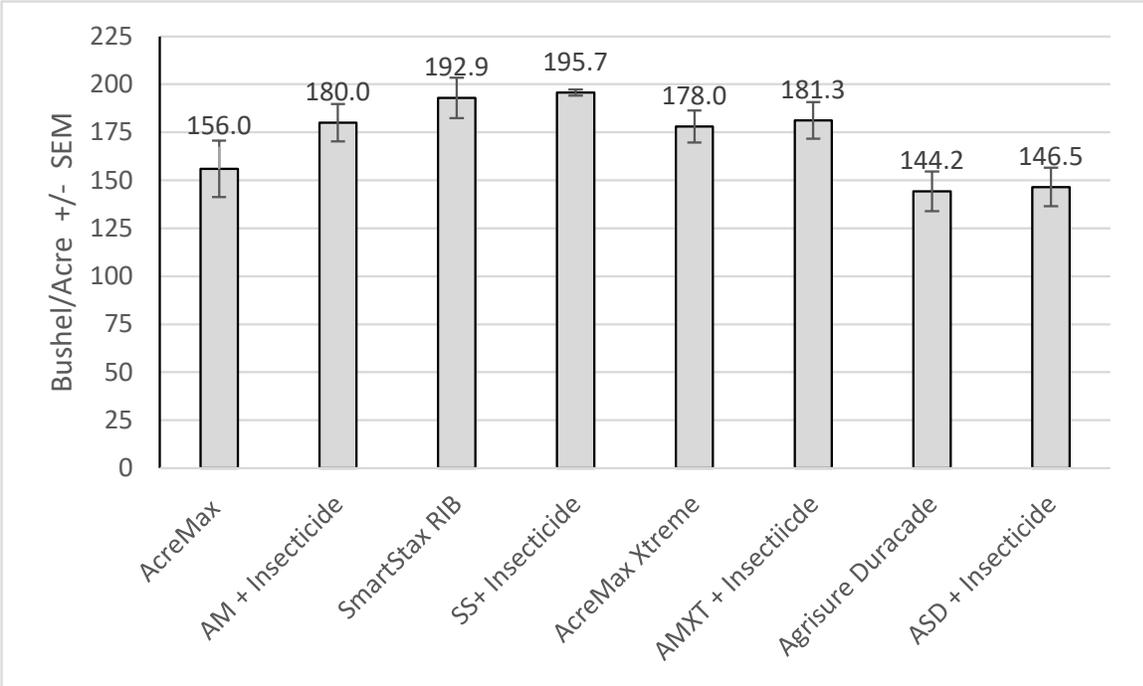
**Table 2.** Efficacy of Bt traits and insecticide against corn rootworm based on injury to corn roots, corn, root lodging and grain yield.



**Figure 2.** Effect of layering an in-furrow insecticide (Aztec HC@ 1.5 oz. /1000 row-foot) on node injury scores of the root system of hybrids with varying Bt-RW traits.



**Figure 3.** Effect of layering in-furrow insecticide (Aztec HC@ 1.5 oz. /1000 row-foot) on corn root- lodging scores for hybrids with varying Bt-RW traits.



**Figure 4.** Effect of layering an in-furrow insecticide (Aztec HC@ 1.5 oz. /1000 row-foot) on corn yields of four hybrids with varying Bt-RW traits.