SW MN IPM RESEARCH - 2017

STUDY: 2017 AMVAC Rootworm on Trait

INVESTIGATOR:
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Travis Vollmer – University of Minnesota Southwest Research and Outreach Center

OBJECTIVE: Evaluate efficacy against corn rootworm (CRW) larvae and yields of Aztec HC, Index and no-at-plant insecticide applied to two refuge hybrids without a Bacillus thuringiensis rootworm trait (Bt-RW) pyramid hybrids.

CROP INFORMATION
Crop: Corn (Zea mays)  Cultivar: See treatment list
History:
2013: Cry 3Bb1 Corn  2014: Cry 3Bb1 Corn  2015: Cry 3Bb1 Corn  2016: non-Bt Corn

PEST INFORMATION
This site had a history of Cry 3Bb1 failure in 2015. Western corn rootworm dominated the populations with very few northern corn rootworm adults observed on the studies corn plants or Trece Pherocon® AM traps in 2016 and 2017.

SITE INFORMATION
Location: University of Minnesota Southwest Research and Outreach Center
Lamberton, Redwood County, Minnesota

Soil fertility (2016 sample):
Name: Normania loam
% OM: 4.7  pH: 6.0
P(bray): 21 ppm  K: 104 ppm  Zn: 1.0 ppm

PLANTING INFORMATION
Planting Date: 5/11/2017  Emergence Date: 5/23/2017
Planting Equipment: John Deere (Moline, IL) Max Emerge 4-row narrow planter modified for plot planting with a Precision Planting LLC (Tremont, IL) vacuum system and vSet meters.
Row Spacing: 30-inch  Seeding Rate: 34,000 seeds/acre  Seeding Depth: 2 inch
Soil Temperature: 64° F  Soil Moisture: Dry
Precipitation: Above-average precipitation after planting

PLOT MAINTENANCE
Tillage Fall 2016: Disc Ripper  Tillage Spring 2017: Field cultivator
Fertilizer: 5/10/17  180-60-80
PRE Herbicide: 5/10/17  Harness – 2.6 pts/A
POST Herbicide: 6/19/17  Cornerstone Plus—36 fl. Oz./A
Insecticide: 5/11/17  Part of study. See Treatment List

HARVEST INFORMATION

Harvest equipment: Plot combine (ALMACO, Nevada, IA).
The center two rows of each four-row plot were harvested. Grain yields were adjusted to 15.5% moisture and 56 pounds/bushel.

EXPERIMENTAL DESIGN

Study Design: 4 X 3 factorial  Treatments: 12  Replications: 4
Treated Plot Width: 10 foot (four 30-inch rows)  Treated Plot Length: 30 foot

TREATMENTS EVALUATED

<table>
<thead>
<tr>
<th>Trt No.</th>
<th>Hybrid/Trait Factor</th>
<th>Treatment Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hybrid &amp; Insecticide Trait</td>
<td>Bt-RW protein(s)</td>
</tr>
<tr>
<td>1</td>
<td>DKC 53-58RIB Blend H1 GENVT2PRIB none</td>
<td>None H2</td>
</tr>
<tr>
<td>2</td>
<td>DKC 53-58RIB Blend H1 GENVT2PRIB none</td>
<td>Aztec HC I2</td>
</tr>
<tr>
<td>3</td>
<td>DKC 53-58RIB Blend H1 GENVT2PRIB none</td>
<td>Index I3</td>
</tr>
<tr>
<td>4</td>
<td>DKC 53-56RIB Blend H2 GENSSRIB Cry 3Bb1+34/35 Ab1</td>
<td>None I1</td>
</tr>
<tr>
<td>5</td>
<td>DKC 53-56RIB Blend H2 GENSSRIB Cry 3Bb1+34/35 Ab1</td>
<td>Aztec HC I2</td>
</tr>
<tr>
<td>6</td>
<td>DKC 53-56RIB Blend H2 GENSSRIB Cry 3Bb1+34/35 Ab1</td>
<td>Index I3</td>
</tr>
<tr>
<td>7</td>
<td>P0157R H3 RR2 none</td>
<td>None I1</td>
</tr>
<tr>
<td>8</td>
<td>P0157R H3 RR2 none</td>
<td>Aztec HC I2</td>
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<td>9</td>
<td>P0157R H3 RR2 none</td>
<td>Index I3</td>
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<tr>
<td>10</td>
<td>P0297 AMXT H4 AMXT Cry 34/35 Ab1+mCry3a</td>
<td>None I1</td>
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<td>P0297 AMXT H4 AMXT Cry 34/35 Ab1+mCry3a</td>
<td>Aztec HC I2</td>
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<tr>
<td>12</td>
<td>P0297 AMXT H4 AMXT Cry 34/35 Ab1+mCry3a</td>
<td>Index I3</td>
</tr>
</tbody>
</table>

H1 Dekalb DKC 53-58 Genuity® VT2PRIB Double PRO® RIB Complete®  Monsanto Company
H2 Dekalb DKC 53-56 Genuity® SmartStax® RIB Complete®  Monsanto Company
H3 Pioneer P0157R  DuPont Pioneer
H4 Pioneer P0297 AMXT™ Optimum® AcreMax® Xtreme  DuPont Pioneer

I1 No in-furrow, at-plant insecticide
I2 Aztec® HC at 1.5 oz/1000 row-ft w/ Smart Box® meters  AMVAC Chemical Corporation
I3 Index™ at 12.6 fl oz/acre in-furrow with 5 GPA water  AMVAC Chemical Corporation

Table 1. Hybrids and insecticides evaluated

ASSESSMENT METHODS

Corn rootworm injury:
On July 31, the root systems of five plants were dug in each plot. No effort was made to differentiate refuge plants in selecting or the subsequent rating root systems. After soaking overnight, root systems were power-washed and corn rootworm injury was rated. For each of nodes 5-7, the total roots and the number of roots pruned to 1.5
Root worm injury in plots. This hybrid differed in end of season traits with Aztec HC Minimal CR trait were significantly different with application of insecticides. Differences in root injury caused by rootworms and plant insecticides were also recorded. Root lodging: In this study, lodging associated with corn rootworm damage occurred early and was rated when hybrid was assessed. This first rating was a subjective whole plot 1-5 score: 1) no lodging; 2) occasional plants slightly leaning; 3) slight leaning common or some plants lodged > 45 degrees; 4) plants with severe lodging common; 5) Most plants severely lodged, some may have root broken and exposed. On August 1, lodging was rated as the percentage of the five plants rated for CRW root injury with goose-necked lower stalks. On October 19, the percentage of plants were by determining the percentage of the plants in the center two rows of each plot lodged. At this last rating, a plant was considered lodged if the ear was lodged so low as to present potential harvest issues.

Stalk lodging: Stalk rot was a problem in 2017 fields within the geographic area of the study. This disease was assessed at the same time as root lodging on October 19. In addition to recording stalk-lodged plants, stalks were grasped below the ear and given a gentle push.

Stalks that collapsed were included in the percentage stalk lodged. High percentages of root lodging occurred in some of the plots without Bt-RW and at-plant insecticide. This prohibited making accurate stalk lodging assessments and the level of stalk rot was likely underestimated for these treatments.

RESULTS
The 2017 growing season was wetter than normal with the last 1/2 of May and the first 1/2 of June averaging 2-3 inches above normal. After planting, 3.98 inches of rainfall occurred from May 16 -21. Western corn rootworm damage was severe in this study as well as the adjacent corn plantings in this field.

A factorial analysis of variance for hybrid (Bt-RW trait), insecticide and interactions between hybrid and insecticide is presented in Table 2. Means and mean separations by hybrid, at-plant insecticide, and any interactions between factors are presented for the yield, rootworm root injury, root and stalk lodging variables are presented in Table 3.

Neither Aztec HC nor Index insecticide caused any visible crop injury symptoms.

Neither hybrid nor insecticide significantly affected early emergence and stand or height at V5 (data not shown).

Differences in root injury caused by rootworms and its associated lodging were highly significant for hybrid and at-plant insecticide. Hybrids with and without a Bt-RW trait differed in their response to an at-plant insecticide application. Without an in-furrow, at-plant insecticide root node injury scores (NIS) in the hybrids without a Bt-RW trait were significantly different with mean NIS of 1.7 and 0.9 with Pioneer 0157 R and DK 53-58 VT2, respectively. Minimal CRW injury occurred in the SmartStax RIB and AMXT Bt-RW pyramids, regardless of insecticide.

Aztec HC granules and Index liquid insecticides provided excellent and similar rootworm control.

Hybrids with a Bt-RW pyramid had less root lodging than those without. Both at-plant insecticides reduced lodging of hybrids without a Bt-RW trait to levels similar to the two pyramid hybrids.

Hybrids differed in end-of-season stalk lodging and there is evidence that at-plant insecticides reduced lodging in this study. This response did not appear consistent among hybrids. Stalk and root lodging were confounded in rating of some plots.

The mean yield of the SmartStax hybrid was numerically ca. more than 20 bushels/acre higher where at-plant insecticides were applied but these differences were not statistically significant and did not appear related rootworm injury (Figure 1).
CONCLUSIONS
In the area surrounding the study area, Cry 3Bb1 (VT3) Hybrid showed damage similar to RW susceptible hybrids. The pyramided rootworm traits still appear to be performing well at this site.

Late planting and abundant early growing season moisture presented ideal conditions for at-plant rootworm insecticide performance. Both the dry and liquid in-furrow, at-plant insecticide formulations performed well and provided a significant reduction in injury on CRW-susceptible hybrids. Aztec HC and Index provided higher yield than untreated hybrids. Yield trends followed rootworm insecticide (α = 0.20).

Bt and insecticide are not the only factors that can influence corn yield in the presence of CRW larvae. Root system architecture, root system regenerative abilities and genetic attributes can influence a hybrid’s response to CRW. While a yield response to a soil insecticide can indicate that performance of a Bt-RW trait has been is reduced, it is important to look at root injury and/or beetle populations in conjunction with yield when assessing Bt-performance.

Table 2. Factorial Analysis of Variance (ANOVA) for Table 2. Means and mean separations for corn stands, yield and for corn rootworm and disease associated injury. UMN Southwest Research and Outreach Center, Lamberton, MN 2017.
Table 3. Means and mean separations for corn stands, yield and for corn rootworm and disease associated injury.

UMN Southwest Research and Outreach Center, Lamberton, MN 2017.

<table>
<thead>
<tr>
<th>Rating date</th>
<th>Crop stage</th>
<th>Stand Plants/acre</th>
<th>Root Lodging (1-5) rating</th>
<th>Root NIS</th>
<th>% Control Consist.</th>
<th>Root Lodging % plants</th>
<th>Root Lodging % plants</th>
<th>Stalk rot</th>
<th>Yield Bu./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V5</td>
<td>VT</td>
<td>R1</td>
<td>R1</td>
<td>R1</td>
<td>R6</td>
<td>R6</td>
<td>R8</td>
<td>R8</td>
</tr>
<tr>
<td>6/14/2017</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### A (Hybrid) MEANS

1. Dekalb 53-58 VT2 (no Bt-RW trait)
   - Pioneer 0157 R (no Bt-RW trait)
   - Pioneer 0297 AMXT
   - Aztec HC
   - Tukey’s HSD P=.05
   - Standard Deviation

2. No insecticide
   - Standard Deviation

### B (Insecticide) MEANS

1. Dekalb 53-58 SS
2. DeKalb 53-58 SS
3. DeKalb 53-58 SS
4. Pioneer 0157 R
5. Pioneer 0297 AMXT
6. Aztec HC
7. NiS < 0.25

### Table Notes:
- Means and mean separations for corn stands, yield and for corn rootworm and disease associated injury.
- UMN Southwest Research and Outreach Center, Lamberton, MN 2017.
Figure 1. Yield and root nodal injury scores (red dots) for four corn hybrids (CRW traits) and two insecticides. Means and mean separations for corn stands, yield and for corn rootworm and disease associated injury. Means with same letter or symbol do not significantly differ (p= 0.05 Tukey’s HSD). UMN Southwest Research and Outreach Center, Lamberton, MN 2017.

ACKNOWLEDGEMENTS
Matthew Wordes and Adam Hass provided valuable help in plot maintenance and root digs and the root rating process.

We would like to thank AMVAC Chemical Corporation for their support of this study.

Aztec® HC and Index™ are restricted use insecticides.

Always read and follow label directions

Products are mentioned for illustrative purposes only. Their inclusion does not mean endorsement and their absence does not imply disapproval.

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