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MCPR Trade Show

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Rootworm Risk, Transgenic Efficacy and Drought!
Separating Hype from Reality

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Extreme Weather Tested
Corn Rootworm Management
Landscape Effects of Corn Rootworm

Extended Diapause is Alive and Well

8-11-07 Swift County
Photo by Jim Boersma

C/C/C Rotation
Bt-RW Corn

C/SB Rotation
No Insecticide, no Bt-RW trait
Remember: In 2007, we dealt with eggs from 2005 corn rootworm beetles! In 2008, we’ll deal with eggs from 2006 corn rootworm beetles, except in continuous corn fields.
Corn Rootworm Risk in MN Rotated Corn

B. Potter from MDA Survey Data

MDA Plant Pest Survey Program has changed its survey procedures. Relevance of 2006 and 2007 data for maps is questionable.

If you would like to express your opinion on this survey, contact:
Mark Abrahamson (651-201-6505)
Mark.Abrahamson@state.mn.us
Stress Effects of Corn Rootworm Feeding
Corn Root Protection by Insecticides vs Bt-RW Corn

Resulting Zone of Root Protection For T-band Insecticide

Resulting Zone of Root Protection For Bt-RW protein
Rootworm Management Options and Corn Root Injury

Minnesota, 2004

![Bar chart showing the number of roots in different categories for various treatments.](chart.png)
Moisture Stress & Rootworm Management

Ostlie – Rosemount 2006

Tassel Leaf height (inches)

- None: 75.3
- Aztec: 76.5
- Herculex RW: 84.6
- None: 71.8
- Aztec: 76.6
- YieldGard RW: 83.8
Comparison of DK50-20 (YieldGard CB) and DK 51-39 (YieldGard Plus)
Improved Yields w/ Bt-RW Trait
Gyles Randall & Jeff Vetsch, SROC - 2006

Comparison of DK50-20 (YieldGard CB) and DK 51-39 (YieldGard Plus)
Development of Bt- Rootworm Transgenics

**Agrisure (Syngenta)**
- Moderate dose event (MIR604)
- Expresses the Bt protein modified Cry3Aa
- EPA registration fall 2006; USDA approval spring 2007

**Herculex RW & Herculex Xtra (Dow - Mycogen / Pioneer)**
- Moderate dose event (DAS 59122-7)
- Expresses the Bt proteins Cry 34/35, a binary toxin
- Approved for sale in 2005

**YieldGard RW & YieldGard Plus (Monsanto)**
- Moderate dose event (MON863)
- Expresses the Bt protein Cry3Bb
- Approved for sale in 2003

**YieldGard VT (Monsanto)**
- Moderate dose event stacked with Bt-ECB and RR2 genes
- Expresses the Bt protein Cry3Bb
- Approved for sale in 2007

**SmartStax**
- Stack of 8 genes including YieldGard VT and Herculex RW

Transgenic Technology: EPA requires Insect Resistance Management (IRM) Plans
Insecticide Options for Managing Corn Rootworm Injury

**Granules**
- Aztec 2.1G, 4.67G*
- Counter 15G
- Empower² 1.15G
- Force 3G*
- Fortress 2.5G, 5G*
- Lorsban 15G***
- Thimet 15G & 20G

* Available in SmartBox
*** EPA Reviewing Petition To Cancel all Uses

**Liquids**
- Capture 2E / LFR**
- Force CS**
- Furadan 4F
- Regent 4SC**
  ** Mix w/ starter fertilizer

**Seed Treatments**
- Cruiser
- Poncho
Comparative Performance of Bt CRW Events against Corn Rootworms: 2006-7

- **Design**: Factorial combinations of 3 CRW management options (None, soil insecticide, Bt CRW) with four genetic platforms: 2006 (YieldGard RW, Herculex RW) plus 2 more in 2007 (Agrisure RW, YieldGard VT).
- **Soil insecticide**: 2006 - Aztec 2.1G, 2007 - Force 3G
- **Seed treatment**: Poncho 250 on all seed.
- **Locations**: Fields w/ rootworm history
  - 5 in 2006 = Brownton, St. Charles, Rosemount, LeSueur & Granite Falls;
  - 6 in 2007 = Plainview, Rosemount, Waseca, LeSueur, Cleveland & Brownton)
- **Data collected**: root protection, lodging, yield, and corn rootworms emergence
- **Funding**: Rapid Agricultural Response Fund, MN Corn Research & Promotion Council
## Root Protection Provided in 2006 by Corn Rootworm Management at MN Sites

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Unprotected Corn</th>
<th>Aztec 2.1G</th>
<th>Herculex RW</th>
<th>YieldGard RW</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Charles</td>
<td>6.34</td>
<td>1.02 -80.75%</td>
<td>0.26 -93.9%</td>
<td>0.20 -97.6%</td>
</tr>
<tr>
<td>LeSueur</td>
<td>11.96</td>
<td>1.36 -88.5%</td>
<td>1.50 -87.1%</td>
<td>0.13 -98.9%</td>
</tr>
<tr>
<td>Lake Marion</td>
<td>15.67</td>
<td>1.21 -92.3%</td>
<td>0.65 -95.8%</td>
<td>0.00 -100.0%</td>
</tr>
<tr>
<td>Rosemount</td>
<td>26.45</td>
<td>3.40 -87.3%</td>
<td>1.38 -94.2%</td>
<td>0.62 -97.9%</td>
</tr>
</tbody>
</table>

No significant corn rootworm injury at Granite Falls.
Lodging under Different Corn Rootworm Management Strategies

Herculex RW
- NIR = 0.43
- NIR = 1.16
- NIR = 1.55
- NIR = 2.36

YieldGard RW
- NIR = 0.84
- NIR = 1.23
- NIR = 1.59
- NIR = 2.93

Aztec and Bt-RW corn provided equal lodging protection!
Yield Response to Corn Rootworm Management

Pioneer Hybrids – 2006

Dekalb Hybrids – 2006

Do farmers have a handle on their risk level?
## Comparative Efficacy of Bt-RW Events

<table>
<thead>
<tr>
<th>Location: Species</th>
<th>Beetles / Cage (= 2 plants)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Event</td>
<td>Unprotected</td>
<td>Bt-RW Corn</td>
<td>% Reduction</td>
<td></td>
</tr>
<tr>
<td>LeSueur: NCR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YieldGard</td>
<td>Male</td>
<td>22.25</td>
<td>2.05</td>
<td>89.9%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>28.85</td>
<td>5.15</td>
<td>81.5%</td>
</tr>
<tr>
<td>Herculex</td>
<td>Male</td>
<td>21.70</td>
<td>0.65</td>
<td>97.0%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>29.80</td>
<td>3.45</td>
<td>88.4%</td>
</tr>
<tr>
<td>Rosemount: WCR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YieldGard</td>
<td>Male</td>
<td>38.67</td>
<td>5.71</td>
<td>85.2%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>64.46</td>
<td>5.13</td>
<td>92.0%</td>
</tr>
<tr>
<td>Herculex</td>
<td>Male</td>
<td>34.33</td>
<td>5.79</td>
<td>83.1%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>55.21</td>
<td>9.42</td>
<td>82.9%</td>
</tr>
</tbody>
</table>
Trend Towards Insurance Treatments

Deployed before pests appears

Recent Examples:
- Transgenic corn, soybean aphid sprays & seed applied pesticides

Motivations:
- Farmers = Cheap insurance...saves time, convenient, reduces risk, increases income
- Companies = Stabilizes performance, simplifies inventory, shifts profit centers, leverages market by packaging
- Ag professionals = Simplifies pest management, removes time demands for scouting and timing risks...handle more acres

Sales Myths:
- Plant health
- Exaggerated risk...fear, avoidance

What are the down sides?
- Unnecessary costs, lost flexibility, resistance
Resistance Management Issues: Fading Farmer Compliance?

Complicating Factors

- Refuge hybrids
  - Comparable yield potential?
  - Desired traits?
  - Availability
- Ease of seed change
  - Row boxes vs central fill
  - Split planter
- Refuge management options
  - Equipment issues (granular insecticide boxes, liquid insecticide systems, liquid fertilizer)
  - Adequacy of root protection
- Planting logistics, time requirements and convenience
Yield Response to Corn Rootworm Management

Average of 6 MN Locations

LSD = 11.4 bu/A
Yield Response to
Corn Rootworm Management

Bob Lamprecht – Plainview, MN

LSD = 11.4 bu/A
Yield Response to Corn Rootworm Management

Ken Ostlie – Rosemount, MN

LSD = 11.4 bu/A
Comparative Efficacy of Bt - RW Events
Ostlie - Rosemount 2007

Design: Factorial combinations of 3 Bt-RW events (YieldGard VT3 – DK 5259, Herculex Xtra – P37Y14, Agrisure – N45A5) and their isolines (DK5263, P37Y13, N45A6) from the same genetic family.


Seed treatment: Poncho 250 on all seed.

Tents: Erected July 2-3, re-setup on July 5-6 after significant lodging. Covered ca. 80 plants, replicated 3 times.

Data collected: Beetles collected ca. 3X per week.

Funding: Rapid Agricultural Response Fund, MN Corn Research & Promotion Council, & Syngenta
## Comparative Efficacy of Bt-RW Events

### Minnesota - 2007

<table>
<thead>
<tr>
<th>Hybrid Family / Event</th>
<th>Western Corn Rootworm</th>
<th>Northern Corn Rootworm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Refuge Hybrid</td>
<td>Bt-RW Hybrid</td>
</tr>
<tr>
<td>DK 5263/5259 VT3</td>
<td>3017a</td>
<td>129d</td>
</tr>
<tr>
<td>P37Y13/14 Herculex Xtra</td>
<td>2672a</td>
<td>100d</td>
</tr>
<tr>
<td>NK45A6/5 Agrisure</td>
<td>2806a</td>
<td>416c</td>
</tr>
<tr>
<td>NK45A6 + Force 3G</td>
<td>1017b</td>
<td>63.8</td>
</tr>
</tbody>
</table>

Means followed by the same letter do not differ statistically (p<0.05).
# Emergence Shifts with Bt-RW Events

## 50% Emergence Date (Day of Year)

<table>
<thead>
<tr>
<th>Hybrid Family: (Event)</th>
<th>Western Corn Rootworm</th>
<th>Northern Corn Rootworm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Refuge</td>
<td>Bt-RW</td>
</tr>
<tr>
<td>DK 5263 (Yieldgard VT3)</td>
<td>199.8</td>
<td>208.4</td>
</tr>
<tr>
<td>P37Y13 (Herculex Xtra)</td>
<td>200.2</td>
<td>206.4</td>
</tr>
<tr>
<td>NK ???? (Agrisure) [+Force 3G]</td>
<td>199.0</td>
<td>207.1</td>
</tr>
<tr>
<td></td>
<td>202.4</td>
<td></td>
</tr>
</tbody>
</table>
Resistance Management Issues: Corn Rootworm Requirements

Refuge Requirements for all Events

- Up to 80% may be Bt Rootworm hybrids.
- Plant a refuge on *every farm* in the same field or an adjacent one.
- The refuge hybrid(s) may be treated with insecticides for larval corn rootworm and stand-reducing insects.
- Plant a refuge at the same time as Bt Rootworm is planted.
- If adjacent, plant the refuge and Bt Rootworm corn to fields with a similar crop history.
- Mixing refuge and Bt Rootworm seed is not permitted at this time.
Performance issues have been reported from Bt-RW corn in Illinois, Iowa, Nebraska…and Minnesota
A New Complication?
Corn Rootworm Egglaying
Near RoundUp Ready® Volunteer Corn
Control Weedy Grass Hosts Early in Bt - RW Corn

Journey & Ostlie @ Rosemount, MN

Stewardship critical: Keep early-season weedy grasses under control!
NCRW beetles/Pherocon AM trap/week
Redwood County, MN 2007

- no volunteer corn
- volunteer corn (1875 ppa)
- volunteer corn (3750 ppa)
- volunteer corn (7500 ppa)

Graph showing the number of NCRW beetles per week on different dates.
- 7/23/2007: Low numbers for all configurations.
- 8/7/2007: Significant increase in numbers, especially for the volunteer corn (7500 ppa) configuration.
- 8/14/2007: Moderate numbers across all configurations.
- 8/21/2007: Moderate numbers across all configurations.

volunteer corn (1875 ppa)
volunteer corn (3750 ppa)
volunteer corn (7500 ppa)
Your Challenge:
Getting a Handle on Risk!

Scout!

1. Decide if you need to manage corn rootworms
2. Target where to plant Bt-RW corn
3. Choose option for refuge mgmt.
Your Challenge:
Getting a Handle on Risk!

Check Out Lodging!

Dig Roots!

Think Iceberg!
Your Challenge: Getting a Handle on Risk!

Test Strips!

Dig Roots!
Your Challenge: Watch Out for Resistance

Dig Roots!
Ensure the Value of Bt Corn: Get out of the Insurance Rut

- Scout fields to gauge rootworm risk
  *Bt corn, rotated corn & continuous corn*
- Ask yourself the key question:
  *Do rootworms need to be managed in this field?*
- Make sound hybrid selections
  *Bt genes only protect yield potential!*
- Make sure the refuge does its job!
  *Split Planter > Block > Adjacent Field*
  - Match cropping practices closely
    (maturity, planting date, tillage, etc.)
  - Protect roots with insecticide, if needed
Research sponsored by:
Minnesota Corn Research & Promotion Council
Legislative Rapid Agricultural Response Fund

Logistical assistance provided by Monsanto, Pioneer HiBreds, and Syngenta Seeds

Special thanks to the cooperating farmers and extension educators!