Responding to Rootworm Trait Failures

Frank B. Peairs
Colorado State University
(970) 491-5945
Frank.Peairs@Colostate.Edu

WESTERN CORN ROOTWORM

EGGS: In soil from August to May
LARVAE: Feed on corn roots during June and early July
PUPAE: In soil during July
ADULTS: Emerge in July and August. Feed on corn and other plants. Lay eggs in corn until frost.

WESTERN CORN ROOTWORM DAMAGE

AVERAGE GRAIN YIELD LOSS* TO WESTERN CORN ROOTWORM

• Loss of 1 node = 18% yield loss
• Affected by location, weather, year

*Excludes lodging losses

Bt Toxins - Rootworm

<table>
<thead>
<tr>
<th>TOXIN</th>
<th>EVENT</th>
<th>TRADENAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cry3Ab1/Cry35Ab1</td>
<td>DAS 59122-7</td>
<td>Herculex RW</td>
</tr>
<tr>
<td>Cry3Bb1</td>
<td>MON 863</td>
<td>YieldGard Corn Rootworm</td>
</tr>
<tr>
<td>Cry3Bb1</td>
<td>MON88017</td>
<td>YieldGard VT</td>
</tr>
<tr>
<td>mCry3Aa</td>
<td>MIR 604</td>
<td>Agrisure RW</td>
</tr>
<tr>
<td>eCry3.1Ab</td>
<td>S907</td>
<td>Agrisure Duracade</td>
</tr>
</tbody>
</table>
Multiple Toxins: Agrisure 3122, AcreMax XTreme, SmartStax

- 2-3 lep toxins
- 2 rootworm toxins
- LibertyLink
- glyphosate tolerant
- RIB and 5% refuges

RIB Strategy

- Uniform rootworm mating (exposed vs not exposed) achieved more quickly
- Ear protection may be reduced due to refuge pollen
Rootworm Efficacy Issues

- All single-toxin events have had performance problems, which may or may not be due to resistance (environmental, rootworm abundance, seed source)
- Two-toxin events seem to have fewer problems
- Some evidence for Cry3 cross-resistance

Rootworm Efficacy Issues (cont.)

- Lab resistance is documented for all events
- Level of expression
  - Not high dose
  - Not as effective as corn borer events

Documented Field Resistance

- Failures of cry3Bb1 events in NE Iowa
- Associated with continuous corn (same event) and low refuge compliance
- Many other reports, especially in NE and CO

mCry3Aa root from Mesa County

Confirmed Failures

- Take an IPM approach!
  - Rotate
  - Untraited hybrid + larval control based on thresholds
  - Adult control
  - 2-toxin events
  - Spider mites

Rootworm Efficacy Issues (cont.)

- New events are in continual development
  - New Bt toxins and combinations
  - RNA interference
  - New non-Bt toxins
Crop rotation is an highly effective nonchemical control if economics permit

- Larvae have narrow host range
- Newly hatched larvae have limited mobility
- Eggs are laid in current crop
- If following crop is not corn -- larvae starve

CHEMICAL CONTROL STRATEGIES FOR WESTERN CORN ROOTWORM

SOIL TREATMENTS
SEED TREATMENTS
TRANSGENIC HYBRID

EGG LARVA PUPA ADULT

SEPTEMBER - JUNE JUNE - JULY JULY - AUGUST JULY - SEPTEMBER

PRE-EMERGE TREATMENT DECISION

- One scouting report in prior season with more than 18,000 beetles per acre
- Unscouted continuous corn

POSTEMERGE TREATMENT DECISION

- One scouting report in prior season with more than 18,000 beetles per acre
- Unscouted continuous corn
- 1 – 2 larvae per root system
- >8 on a single-trait is indication of failure
**Post-emergence - Chemigation**

- Lorsban 4E*, 1 lb (ai)/acre
- Untreated
- 1.2 root rating, 182 bu/acre
- 3.8 root rating, 132 bu/acre

*Bifenthrin also reported to work well

**Adult Treatment Decision**

- 3 Beetles per 10 ear zones* (2 for retreat)
- 6 Beetles per 10 plants* (4 for retreat)
- 6 Beetles per trap per day (4 for retreat)

*(30,000 plants/acre)

**Adult Treatment Timing**

- At or above the decision level
- 10% gravid females
- 2 – 3 weeks after first beetle

**Adult Treatment Efficacy**

- Adult control (1991) 2.2
- Larval control (1992) 3.8
- Untreated (1991, 1992) 5.1

**Pollinator Protection**

- Properly timed western corn rootworm adult treatments can occur during pollen shed:

**Pollinator Protection is Required!**
CORN SPIDER MITES

TSM  BGM

TYPICAL CORN SPIDER MITE SOURCES

TSM  BGM

CORN SPIDER MITES: RESPONSE TO DIMETHOATE

Texas  Colorado

CORN SPIDER MITES: PEST STATUS

• BGM is native
• Pest of various grass crops
• Key pest of Colorado corn

CORN SPIDER MITES: LIFE CYCLE (BGM)

• Egg, 3 immature stages, adult
• Egg to adult in 10 – 20 days
• In lab, 70x increase per generation
**CORN SPIDER MITES: LIFE CYCLE (BGM)**

- Overwinter as orange-yellow fertilized females on alternate grass hosts
- Walk or “balloon” back to corn in spring

**CORN SPIDER MITES: LIFE CYCLE (BGM)**

- Infestations start on undersides of lower leaves
- Gradually move into upper part of plant
- Most damage occurs between pollen shed and denting

**CORN SPIDER MITES: FACTORS FAVORING BGM**

- Drought stress
- Post-reproductive growth stages
- No TSM
- Insecticides
- Low rainfall
- Few natural enemies
- >95F temperatures

**INFLUENCE OF IRRIGATION ON CORN SPIDER MITES**

- Grain yield loss over 25 years at Rocky Ford – 22%
- Dry matter loss in 3 silage studies – 25%
CORN SPIDER MITES:
Response to insecticide treatment

Biological control is often the only control needed for spider mites in corn

Spider Mite Management Options

- Preserve biological control
- Preventive miticides
- Reactive miticides
- Preventive vs. reactive depends on local resistance problems, other pests

CORN SPIDER MITES:
PREVENTIVE MITICIDE QUESTIONS

- Crop near tasseling?
- Most plants infested?
- Parts of crop drought stressed?
- Mite predators scarce?

CORN SPIDER MITES: PREVENTIVE MITICIDE QUESTIONS

- Max temps ≥ 95°F for next 2 weeks?
- Field history of mite problems?
- TSM problems expected?

≥3 “Yes” answers indicates reasonable need for preventive treatment

PREVENTIVE MITICIDES

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2010</th>
<th>2011</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onager 15, 10 oz</td>
<td>(26*)</td>
<td>(20)</td>
<td>(20)</td>
<td>(20 &amp; 16)</td>
<td>(20 &amp; 20)</td>
</tr>
<tr>
<td>Oberon 4SC + dimethoate, 4 + 16 oz</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>--</td>
</tr>
<tr>
<td>Oberon 4SC, 4 oz</td>
<td>4</td>
<td>12</td>
<td>9</td>
<td>17 &amp; 13</td>
<td>8</td>
</tr>
<tr>
<td>Comite II + dimethoate, 36 + 16 oz</td>
<td>5</td>
<td>8</td>
<td>10</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>Comite II, 36 oz</td>
<td>18</td>
<td>20</td>
<td>19</td>
<td>13</td>
<td>--</td>
</tr>
<tr>
<td>Zeal 72W, 2 oz**</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Portal, 32 oz</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>8</td>
</tr>
</tbody>
</table>

*Total treatments in trial
**Not registered
**CORN SPIDER MITES:**

**ACTION_THRESHOLDS**

**Reactive Treatments**

- Damage in lower 1/3 of plant and colonies in middle 1/3
- Texas A&M dynamic threshold

**REACTIVE MITICIDES**

**Rank in trial**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(12*)</td>
<td>(14)</td>
<td>(18)</td>
<td>(15)</td>
<td>(26)</td>
<td>(20)</td>
<td>(20 &amp; 16)</td>
<td>(20 &amp; 20)</td>
<td></td>
</tr>
<tr>
<td>Bifenthrin</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>23</td>
<td>14</td>
<td>20 &amp; 8</td>
<td>--</td>
</tr>
<tr>
<td>Bifenthrin + Dimethoate</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>1 &amp; 4</td>
</tr>
<tr>
<td>Dimethoate</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>14</td>
<td>19</td>
<td>6</td>
<td>16</td>
<td>11 &amp; 5</td>
</tr>
<tr>
<td>Agri-Mek**</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>--</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Portal</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>11</td>
<td>2</td>
</tr>
</tbody>
</table>

*Total treatments in trial
**Not registered until 2014

- 3 GPA minimum
- Control improves up to 5 GPA, perhaps higher
- Buffer dimethoate
- Surfactants?