Institute of Ag Professionals

Proceedings of the

2014 Crop Pest Management Shortcourse &

Minnesota Crop Production Retailers Association Trade Show

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Big Data from Multistate Research on Soybean Aphid Management

Presented by Kelley J. Tilmon
South Dakota State University

Photo By: R. Venette
Multi-Disciplinary, Multi-State Aphid Project 2012-2014

- Funded by the North Central Soybean Research Program

- 26 interdisciplinary collaborators throughout the North Central region
  - entomologists, plant breeders, molecular biologists, extension specialists, ag economist
### Major Project Objectives

1. **Integrated pest management** (Kelley Tilmon, SDSU)
2. **Breeding/plant resistance** (Brian Diers, UIL)
3. **Aphid biotypes** (Andy Michel, OSU)
4. **Biological control** (George Heimpel, UMN)
5. **Extension and outreach** (Erin Hodgson, ISU)
Project Collaborators

- Minnesota: Bruce Potter, George Heimpel
- Michigan: Dechun Wang
- Indiana: Christian Krupke
- Iowa: Matt O’Neal, Erin Hodgson, Bryony Bonning
- Kansas: Brian McCormack, John Reese
- Nebraska: Tom Hunt, Tiffany Heng-Moss, Blair Siegfried
- South Dakota: Kelley Tilmon, Louis Hesler
- Wisconsin: Dave Hogg, Eileen Cullen, Paul Mitchell
- North Dakota: Deirdre Prischmann, Jason Harmon, Jan Knodel
- Ohio: Andy Michel, Rouf Mian
- Delaware: Doug Tallamy, Keith Hopper
Soybean aphids are still a problem…

- Soybean aphid still costs producers a lot of money
  - Estimated $827 million annual expenditures for foliar and seed insecticides

- Array of management options (seed treatments, resistant varieties, etc.)

- Research to identify the most profitable management approaches and outreach to communicate them
Soybean Aphid Management Options

- Foliar Sprays
- Seed Treatments
- Early Season Predation
- Late Season Predation
- Plant Resistance: Rag genes

Slide courtesy of Christian Krupke, Purdue University
1. Insecticidal seed treatments

2. Aphid-resistant soybean varieties
Neonicotinoid Seed Treatments

- Target insects
  - Often bundled with fungicides
- Taken up in plant tissue after germination
- Examples:
  - imidacloriprid (e.g., Gaucho)
  - thiamethoxam (e.g., Cruiser)
Neonicotinoid seed treatments are widespread

- Most annual crops grown from treated seed
  - Virtually all corn (95+ million acres)
  - 60-75% of soybean (more in some areas) (70+ million acres)
  - Canola, wheat cotton
- Total of ≈ 200 million acres/year

*Slide courtesy of Christian Krupke, Purdue University*
Insecticidal seed treatments in soybean: A current hot topic

MEMORANDUM

SUBJECT: Benefits of Neonicotinoid Seed Treatments to Soybean Production
A key question…

- Are insecticidal seed treatments a good insect control investment in soybeans in the North Central region?
  
  - In 2014 North Central producers spent approximately $316 million on them
NCSRP Multistate Experiment, 2012-2013

Broad-scale study of thiamethoxam seed treatments

- 7-state field study; 8 locations; 2 years
  - Wide range of conditions
- Experiment led by Dr. Christian Krupke (Purdue)
- Economic analysis by Dr. Paul Mitchell, ag economist (University of Wisconsin)
Seed Treatment Study Collaborators

- Eileen Cullen (UW-Madison)
- Erin Hodgson (ISU)
- Janet Knodel (NDSU)
- Brian McCornack (KSU)
- Paul Mitchell (UW-Madison)
- Bruce Potter (UMN-Lamberton)
- Kelley Tilmon (SDSU)
Questions about thiamethoxam seed treatment on soybean

- Window of activity
- Expression in pollen
- Efficacy against soybean aphid
- Net return of thiamethoxam vs. scouting/thresholds/foliar-treatment
Window of activity
Thiamethoxam in soybean, post seed-treatment

- Sampled plant tissue in each location through growing season for thiamethoxam levels
- Newest trifoliate; pollen (when flowering)
- Untreated plants vs. thiamethoxam-treated plants
- LC-MS/MS analysis to determine when/where/how much insecticide is present in plant tissues
Good news for pollinators: no neonicotinoids detected in soybean pollen of any treatment.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Days post planting</th>
<th>Untreated seed</th>
<th>CruiserMaxx seeds</th>
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<tbody>
<tr>
<td>VE*</td>
<td>8</td>
<td>31.4 (3.6)</td>
<td>6509.3 (1204.3)</td>
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<tr>
<td>VC*</td>
<td>11</td>
<td>13.7 (8.2)</td>
<td>9075.0 (4550.6)</td>
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<tr>
<td>V1*</td>
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<td>8.0 (2.7)</td>
<td>1366.1 (405.7)</td>
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<tr>
<td>V1/V2*</td>
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<td>39.3 (26.4)</td>
<td>151.3 (67.4)</td>
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<td>20</td>
<td>0.2 (0.1)</td>
<td>10.0 (4.3)</td>
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<td>0.7 (1.3)</td>
<td>1.0 (0.3)</td>
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<tr>
<td>V3</td>
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<td>2.3 (3.1)</td>
<td>6.7 (4.1)</td>
</tr>
<tr>
<td>V5</td>
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<td>0.1 (0.1)</td>
<td>0.5 (0.08)</td>
</tr>
<tr>
<td>V6</td>
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<td>2.0 (3.8)</td>
<td>0.7 (0.2)</td>
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<tr>
<td>R1</td>
<td>35</td>
<td>0.02 (0.01)</td>
<td>0.1 (0.07)</td>
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<td>38</td>
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<td>0.08 (0.003)</td>
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Concentrations (ppb) of thiamethoxam from foliage samples (n=88 samples)

* = significant differences detected
ANOVA, $F=20.03$; df=1,120; $P<0.001$

Slide courtesy of Christian Krupke, Purdue University
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Within 3 weeks after planting, concentration of thiamethoxam in soybean foliage is equivalent to non-treated plants.

Slide courtesy of Christian Krupke, Purdue University
Thiamethoxam concentration in new soybean vegetation
Thiamethoxam in new tissue fades 3 weeks after planting (early/mid June)

Aphids typically start to build (mid/late July)
What about yield?
2012 Study Design

• Five states, six locations

• Minimum plot size = 40’ x 4 rows (30”); 4 reps

• Three treatments (all with same soybean variety at a given location):
  – Naked seed
  – ApronMaxx
  – CruiserMaxx
• 2012 was a drought year
• Little/no soybean aphid pressure except in Minnesota
NCSRP study results 2012

- No significant difference between any treatments
- No intrinsic “yield bump” from seed treatment

<table>
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<tr>
<th>STATE</th>
<th>TREATMENT</th>
<th>YIELD (bu/acre)</th>
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<tr>
<td>IN</td>
<td>Naked seed</td>
<td>24.0</td>
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<tr>
<td></td>
<td>ApronMaxx</td>
<td>23.9</td>
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<tr>
<td></td>
<td>CruiserMaxx</td>
<td>23.6</td>
</tr>
<tr>
<td>MN</td>
<td>Naked seed</td>
<td>54.1</td>
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<tr>
<td></td>
<td>ApronMaxx</td>
<td>52.0</td>
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<tr>
<td></td>
<td>CruiserMaxx</td>
<td>50.2</td>
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<tr>
<td>ND (2 locations)</td>
<td>Naked seed 1</td>
<td>37.2</td>
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<tr>
<td></td>
<td>ApronMaxx 1</td>
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<td></td>
<td>CruiserMaxx 1</td>
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<td>Naked seed 2</td>
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<td>SD</td>
<td>Naked seed</td>
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<td>ApronMaxx</td>
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<td>WI</td>
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<tr>
<td></td>
<td>ApronMaxx</td>
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<td></td>
<td>CruiserMaxx</td>
<td>67.5</td>
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</table>

Table courtesy of Christian Krupke, Purdue University
2013 Study Design

- Added additional states/sites (7 states, 8 locations)

- Added an “IPM treatment” = foliar insecticide applied when aphids reach 250 aphid/plant threshold

- Conducted economic analysis to compare likelihood of return on seed treatment vs. scout+spray
**State** | **Treatment** | **Yield (bu/acre)** 
--- | --- | --- 
MN | Naked seed | 45.2 
| Naked + Warrior II | 49.1 
| ApronMaxx | 48.6 
| CruiserMaxx | 45.9 
ND (2 locations) | Naked seed 1 | 40.4 
| Naked + Warrior II | 40.8 
| ApronMaxx 1 | 38.9 
| CruiserMaxx 1 | 41.6 
| Naked seed 2 | 50.2 
| Naked + Warrior II | 49.6 
| ApronMaxx 2 | 48.7 
| CruiserMaxx 2 | 49.6 
IN | Naked seed | 41.6 
| Naked + Warrior II | 39.9 
| ApronMaxx | 43.8 
| CruiserMaxx | 41.9 
KS | Naked seed | 61.2 
| Naked + Warrior II | 61.2 
| ApronMaxx | 63.4 
| CruiserMaxx | 56.4 
SD | Naked seed | 28.5 
| Naked + Warrior II | 43.6 
| ApronMaxx | 39.5 
| CruiserMaxx | 39.6 
WI | Naked seed | 52.9 
| Naked + Warrior II | 53.5 
| ApronMaxx | 55.7 
| CruiserMaxx | 57.9
CruiserMaxx
sig. lower
CruiserMaxx sig. lower

IPM sig. higher
CruiserMaxx sig. lower

IPM sig. higher

ApronMaxx and CruiserMaxx sig. higher
No sig. differences
IPM (scout and treat) vs. CruiserMaxx-only: Economic analysis

Common assumptions:
Soybean price = $11.36/bu
Soybean yield = 50 bu/acre

Slide courtesy of Christian Krupke, Purdue University
Question:

- What are the chances of a net return with either of these approaches?
  - Thiamethoxam seed treatment
  - scouting/thresholds/foliar-treatment

- Assumes an “aphid year”

- Analysis by Dr. Paul Mitchell, ag economist, UW Madison
IPM vs. CruiserMaxx-only: Economic analysis

**Costs of CruiserMaxx-only approach:**  
$7.67/acre insecticidal seed treatment
IPM vs. CruiserMaxx-only: Economic analysis

Costs of CruiserMaxx-only approach: $7.67/acre insecticidal seed treatment

Slide courtesy of Christian Krupke, Purdue University
IPM vs. CruiserMaxx-only: Economic analysis

Costs of CruiserMaxx-only approach: $7.67/acre insecticidal seed treatment

= 66.2% chance of positive net return; average return of $6.02/acre
IPM vs. CruiserMaxx-only: Economic analysis

**Costs of IPM approach:**
- $7.44/acre scouting
- $7.20/acre application cost
- $4.43/acre cost of insecticide

Assume 25% of fields require treatment

**Costs of CruiserMaxx-only approach:**
- $7.67/acre insecticidal seed treatment

= 66.2% chance of positive net return; average return of $6.02/acre

*Slide courtesy of Christian Krupke, Purdue University*
IPM vs. CruiserMaxx-only: Economic analysis

Costs of IPM approach:
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= 66.2% chance of positive net return; average return of $6.02/acre

Slide courtesy of Christian Krupke, Purdue University
IPM vs. CruiserMaxx-only: Economic analysis

**Costs of IPM approach:**
- $7.44/acre scouting
- $7.20/acre application cost
- $4.43/acre cost of insecticide

Assume 25% of fields require treatment

= 94.5% chance of positive net return; average return $21.02/acre

**Costs of CruiserMaxx-only approach:**
- $7.67/acre insecticidal seed treatment

= 66.2% chance of positive net return; average return of $6.02/acre

*Slide courtesy of Christian Krupke, Purdue University*
The Upshot

• In a year with aphid pressure, across the region, thiamethoxam seed treatment might provide a net return (66% chance), but classic IPM (scouting/threshold/foliar insecticide) has a better chance providing a net return (94% chance)

• Potential net return higher for IPM ($21) than seed treatment ($6)
Will seed treatment let me walk away from the problem? A word of caution...
Seed Treatment Study in South Dakota, 2013

- ApronMaxx
- Cruiser
- CruiserMaxx
- No Treatment
- IPM

Aphids/Plant

Damage Boundary

Dates:
- 6/25
- 7/1
- 7/8
- 7/15
- 7/23
- 7/29
- 8/6
- 8/12
- 8/19
- 8/26
If you didn’t scout and spray these treatments you lost money. If you did, you paid for your insect management twice.
Insecticidal seed treatments in soybean: A current hot topic

MEMORANDUM

SUBJECT: Benefits of Neonicotinoid Seed Treatments to Soybean Production
Bean Leaf Beetle

• Seed treatment and early-season bean leaf beetle
• Different pest complexes in Mid-south
Summary

- CruiserMaxx-treated soybeans are not toxic for long enough to control aphids in many parts of the upper Midwest.
- Know what you can reasonably expect from the product.
- Risk/benefit calculations will differ for each producer.
- Insecticidal seed treatment in soybean has a role for some producers, in some situations.
NOT...
Aphid-Resistant Varieties

- Aphid-resistant varieties are under-utilized in soybean IPM
- One of our most promising management tools
- Can eliminate the need to spray in many cases
- Rag1 and Rag2 are commercially available
- Gene pyramid varieties are on the horizon
Yield loss to aphids kg/hectare (± SEM)

- Susceptible: Yield loss significantly higher than Rag1 and Rag2, with a p-value of < 0.0001.
- Rag1: Yield loss is significantly lower than Susceptible, with a p-value of 0.01.
- Rag2: Yield loss is not significantly different from Susceptible.
- Rag1 + Rag2: Yield loss is not significantly different from Rag1 or Rag2 individually.

2011-2013 Multi-State NCSRP Project
• Can be bred into high-yield lines

• No yield penalty
High yielding conventional experimental lines with *Rag1* and *Rag2* combined (B. Diers, UIL)

<table>
<thead>
<tr>
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<th>Rank</th>
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Yield Loss in a Resistant Line under Heavy Aphid Pressure (Rosemont, MN 2008)

![Graph showing yield loss in a resistant line and an susceptible line under heavy aphid pressure.](#)
Thanks for Checkoff Support for State and Regional Projects

The North Central Soybean Research Program, a collaboration of 12 state soybean associations, invests soybean checkoff funds to improve yields and profitability via university research and extension.
Thanks!

Questions?