New Technologies and Tactics for IPM in Snap Beans and Cucurbits

Central Wisconsin Processing Crops Meeting
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## Wisconsin Vegetable Production Statistics (Wis. Ag. Stats. 2007)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Nat. Rank</th>
<th>Acres</th>
<th>% of U.S.</th>
<th>$ Value (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>4</td>
<td>64,500</td>
<td>7</td>
<td>$209</td>
</tr>
<tr>
<td>Sweet corn (Proc)</td>
<td>2</td>
<td>97,400</td>
<td>23</td>
<td>$51</td>
</tr>
<tr>
<td>Carrot (Proc)</td>
<td>1</td>
<td>4,100</td>
<td>29</td>
<td>$5</td>
</tr>
<tr>
<td>Snap beans</td>
<td>1</td>
<td>74,000</td>
<td>35</td>
<td>$31</td>
</tr>
<tr>
<td>Peas</td>
<td>2</td>
<td>38,500</td>
<td>21</td>
<td>$19</td>
</tr>
<tr>
<td><strong>Minor crops (vine crops)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumbers (pickles)</td>
<td>4</td>
<td>6,100</td>
<td>6</td>
<td>$9</td>
</tr>
<tr>
<td>Melon (cantaloupe)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melon (watermelon)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melon (honeydew)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumpkins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squash (winter and summer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Small-acreage fresh market production continues to expand. Anecdotal statistics estimate ca. 1,500 small-acreage producers that grow over 50 crops in Wisconsin.
Snap bean insect control

- Relatively few insect pests
- Highly pest resistant plant
- Ecology, biology of key pests has reduced insecticide use.

- Seed corn maggot
- European corn borer
- Potato leafhopper
European corn borer (ECB)

Appearance
- Adults, gray / brown (1/2”)
- Nocturnal

Occurrence
- Overwinters in Wisconsin
- Broad host range
- Beans, sweet corn, field corn, potatoes, peppers
- 2-3 generations/year
ECB Lifecycle

**Eggs**
- Laid in masses (20-50)
- Black dots at hatch, 5-7 days

**Larva**
- Overwinter in corn stalks
- 5 instars (2-4 weeks) 1\(^{st}\) and 2\(^{nd}\) external.

**Adult**
- 2 normal flight peaks June-Aug (1400 \(DD_{50}\) and 1733 \(DD_{50}\))

**Pupae**
- Inside stems 10-14 days
ECB: Snap bean damage

- Small larvae external
- Damage marginal

- Pods preferred if present
- Serious problem

- Later instars bore into stems
- Plants easily compensate

- Rejection threshold 1/1000
Processing Snap Bean
Production Intervals in Wisconsin

Planting


Harvesting

Date
ECB Management

1. Predict flight with degree days:
   - 1\textsuperscript{st} = 375 DD\textsubscript{50}, 2\textsuperscript{nd} 1400 DD\textsubscript{50}
   - 3\textsuperscript{rd} generation possible in warm years (1733 DD\textsubscript{50})

2. Monitor flights:
   - State network of flight traps
   - DATCP survey

3. Treat plants @ early bloom
   - Blacklight traps:
     (15 & 100 moths/night, 1\textsuperscript{st} and 2\textsuperscript{nd} generation)
New Insecticide Registrations, 2009-10

- **Assail (UPI) revisions - 2008**
  Aphids, Potato leafhopper, Bean leaf beetle, Mexican bean beetle

- **Coragen* (DuPont) Target late 2009-10**
  IR-4 PCR’s completed and submitted to EPA (rynaxypyr)

- **Radiant (Dow AgroSciences)**

- **Lorsban Advanced (Dow AgroSciences)**
  Armyworm, Cutworm and Seed corn maggot

- **Brigade (FMC)**
  bifenthrin

- **Hero (FMC)**
  Pre-mix of zeta-cypermethrin and bifenthrin

- **Brigadier (FMC)**
  Pre-mix of bifenthrin and imidacloprid
ECB Control on Snap Beans:
Foliar Insecticides – Arlington, WI 2008

- University of Wisconsin, Arlington Res Station
- Planting date of May 30, 2008
- Artificial infestations; July 20, July 26
  Five consecutive plants per plot
  Each plant infested with 10 egg masses
- Single foliar application on July 23
- Backpack sprayer delivering 26.5 gpa
- Plot size 4 rows by 25 feet
## ECB Control: Registered Foliar Sprays 3 Days Prior to Application (=Cleanup).


<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/A</th>
<th>Damaged stems</th>
<th>Larvae in stems</th>
<th>% Pod damage</th>
<th>Larvae in pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>---</td>
<td>5.3 ab</td>
<td>2.3 a</td>
<td>22.0 b-g</td>
<td>4.0 abc</td>
</tr>
<tr>
<td>Orthene</td>
<td>1.0 lb.</td>
<td>1.3 ef</td>
<td>0.0 e</td>
<td>10.5 fgh</td>
<td>0.5 ef</td>
</tr>
<tr>
<td>Lannate</td>
<td>3 pt.</td>
<td>3.3 b-f</td>
<td>1.3 a-d</td>
<td>26.9 abc</td>
<td>4.8 ab</td>
</tr>
<tr>
<td>Brigade</td>
<td>4.5 oz.</td>
<td>2.0 def</td>
<td>0.0 e</td>
<td>10.0 fgh</td>
<td>2.0 b-f</td>
</tr>
<tr>
<td>Warrior</td>
<td>3.84 oz.</td>
<td>2.0 def</td>
<td>0.5 cde</td>
<td>10.3 fgh</td>
<td>2.3 b-f</td>
</tr>
<tr>
<td>Mustang Max</td>
<td>4 oz.</td>
<td>4.3 a-d</td>
<td>1.5 abc</td>
<td>15.0 c-h</td>
<td>3.0 b-f</td>
</tr>
<tr>
<td>Spintor</td>
<td>6 oz.</td>
<td>1.5 ef</td>
<td>0.0 e</td>
<td>8.1 h</td>
<td>0.3 f</td>
</tr>
<tr>
<td>Radiant</td>
<td>6 oz.</td>
<td>1.3 ef</td>
<td>0.3 de</td>
<td>11.0 e-h</td>
<td>2.8 b-f</td>
</tr>
<tr>
<td></td>
<td>8 oz.</td>
<td>1.3 ef</td>
<td>0.5 cde</td>
<td>6.7 h</td>
<td>0.8 def</td>
</tr>
</tbody>
</table>
### ECB Control: Registered Foliar Sprays
3 Days Prior to Application (=Cleanup).

<table>
<thead>
<tr>
<th>Treatment</th>
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<th>Larvae in pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>---</td>
<td>5.3 ab</td>
<td>2.3 a</td>
<td>22.0 b-g</td>
<td>4.0 abc</td>
</tr>
<tr>
<td>cyazapyr¹</td>
<td>1.72 oz.</td>
<td>5.3 ab</td>
<td>1.8 ab</td>
<td>36.0 a</td>
<td>4.3 abc</td>
</tr>
<tr>
<td>Coragen¹</td>
<td>3.5 oz.</td>
<td>2.0 def</td>
<td>0.0 e</td>
<td>8.4 h</td>
<td>0.5 ef</td>
</tr>
<tr>
<td></td>
<td>5 oz.</td>
<td>3.5 b-f</td>
<td>1.0 b-e</td>
<td>9.3 gh</td>
<td>0.3 f</td>
</tr>
<tr>
<td>Avaunt²</td>
<td>6 oz.</td>
<td>2.3 c-f</td>
<td>0.5 cde</td>
<td>13.7 c-h</td>
<td>2.8 b-f</td>
</tr>
<tr>
<td>Rimon</td>
<td>12 oz.</td>
<td>2.5 c-f</td>
<td>0.5 cde</td>
<td>17.1 c-h</td>
<td>2.3 b-f</td>
</tr>
</tbody>
</table>

¹MSO added at 0.5% v/v.
²Note: Not registered for use on legume – succulent bean
# ECB Control: Registered Foliar Sprays

3 Days Post Application (=Residual).


<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/A</th>
<th>Damaged stems</th>
<th>Larvae in stems</th>
<th>% Pod damage</th>
<th>Larvae in pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>---</td>
<td>5.3 ab</td>
<td>1.8 a</td>
<td>11.8 b-f</td>
<td>3.0 abc</td>
</tr>
<tr>
<td>Orthene</td>
<td>1.0 lb.</td>
<td>0.3 g</td>
<td>0.0 d</td>
<td>0.0 k</td>
<td>0.0 g</td>
</tr>
<tr>
<td>Lannate</td>
<td>3 pt.</td>
<td>5.0 a</td>
<td>2.0 ab</td>
<td>18.0 ab</td>
<td>2.8 ab</td>
</tr>
<tr>
<td>Brigade</td>
<td>4.5 oz.</td>
<td>1.8 c-g</td>
<td>0.3 d</td>
<td>0.4 k</td>
<td>0.3 fg</td>
</tr>
<tr>
<td>Warrior</td>
<td>3.84 oz.</td>
<td>1.5 d-g</td>
<td>0.3 d</td>
<td>0.0 k</td>
<td>0.0 g</td>
</tr>
<tr>
<td>Mustang Max</td>
<td>4 oz.</td>
<td>0.8 g</td>
<td>0.5 cd</td>
<td>1.0 jk</td>
<td>0.3 fg</td>
</tr>
<tr>
<td>Spintor</td>
<td>6 oz.</td>
<td>2.0 c-g</td>
<td>0.3 d</td>
<td>4.0 g-k</td>
<td>0.3 fg</td>
</tr>
<tr>
<td>Radiant</td>
<td>6 oz.</td>
<td>2.0 c-g</td>
<td>1.0 a-d</td>
<td>2.6 ijk</td>
<td>0.5 fg</td>
</tr>
<tr>
<td></td>
<td>8 oz.</td>
<td>1.3 efg</td>
<td>0.3 d</td>
<td>3.1 h-k</td>
<td>0.0 g</td>
</tr>
<tr>
<td>Treatment</td>
<td>Rate/A</td>
<td>Damaged stems</td>
<td>Larvae in stems</td>
<td>% Pod damage</td>
<td>Larvae in pods</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------</td>
<td>---------------</td>
<td>-----------------</td>
<td>--------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Untreated</td>
<td>---</td>
<td>5.3 ab</td>
<td>1.8 a</td>
<td>11.8 b-f</td>
<td>3.0 abc</td>
</tr>
<tr>
<td>cyazapyr¹</td>
<td>1.72 oz.</td>
<td>5.5 a</td>
<td>0.3 d</td>
<td>13.9 a-e</td>
<td>1.3 c-f</td>
</tr>
<tr>
<td>Coragen¹</td>
<td>3.5 oz.</td>
<td>1.0 fg</td>
<td>0.0 d</td>
<td>1.1 jk</td>
<td>0.0 g</td>
</tr>
<tr>
<td></td>
<td>5 oz.</td>
<td>1.5 d-g</td>
<td>0.3 d</td>
<td>0.8 k</td>
<td>0.0 g</td>
</tr>
<tr>
<td>Avaunt²</td>
<td>6 oz.</td>
<td>1.5 d-g</td>
<td>0.5 cd</td>
<td>2.8 h-k</td>
<td>0.5 fg</td>
</tr>
<tr>
<td>Rimon</td>
<td>12 oz.</td>
<td>2.5 b-g</td>
<td>0.3 d</td>
<td>7.4 e-j</td>
<td>1.3 c-f</td>
</tr>
</tbody>
</table>

¹MSO added at 0.5% v/v.
²Note: Not registered for use on legume – succulent bean
ECB Control on Snap Beans: Systemic Insecticides – Arlington, WI 2008

- University of Wisconsin, Arlington Res Station
- Planting date of May 30, 2008
- Artificial infestations; July 20
  Five consecutive plants per plot
  Each plant infested with 10 egg masses
- In-furrow application (at-plant)
  Backpack sprayer delivering 4.5 gpa
- Plot size 4 rows by 25 feet

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/A</th>
<th>Placement</th>
<th>% Damaged stems</th>
<th>% Damaged pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>---</td>
<td>---</td>
<td>84.0 a</td>
<td>12.9 a</td>
</tr>
<tr>
<td>cyazapyr¹</td>
<td>3.5 oz.</td>
<td>In furrow</td>
<td>80.0 a</td>
<td>7.5 ab</td>
</tr>
<tr>
<td></td>
<td>5.0 oz.</td>
<td>In furrow</td>
<td>46.0 ab</td>
<td>3.5 b</td>
</tr>
<tr>
<td></td>
<td>9.5 oz.</td>
<td>In furrow</td>
<td>24.0 b</td>
<td>2.7 b</td>
</tr>
<tr>
<td>Coragen¹</td>
<td>3.5 oz.</td>
<td>In furrow</td>
<td>52.0 ab</td>
<td>7.2 ab</td>
</tr>
<tr>
<td></td>
<td>6.0 oz.</td>
<td>In furrow</td>
<td>48.0 b</td>
<td>4.4 b</td>
</tr>
</tbody>
</table>

¹Note: Not registered for use on legume – succulent bean
Striped cucumber beetle

*(Acalymma vittatum)*
Striped and Spotted Cucumber Beetles

**Lifecycle**

- Adult beetles 8-10 mm length and 3-4 mm wide
- Striped cucumber beetle *Acalymma vittatum*
- Spotted cucumber beetle *Diabrotica undecimpunctata*
- Striped cucumber beetles overwinter in protected areas as adults and become active in mid-spring.
- Appear early, lay eggs at the base of cucurbits, and have 2 generations / year
- Striped is most severe
Cucumber Beetles: Damage

- Defoliation
- Pollination Interference
- Feeding Scars
- Rindworms
Cucumber Beetles - Bacterial Wilt

- Most damage is from bacterial wilt, *Erwinia tracheiphila*

- Closely associated with beetle, vectored via posterior-station

- No cure for bacteria, control through vector

- Susceptibility:
  
  Melons (not watermelon) > cucumbers > butternut and Hubbard squash

Causal organism = *Erwinia tracheiphila*; Transmitted by cucumber beetle adults
Management - Bacterial Wilt

- Avoidance of bacterial wilt is accomplished through effective cucumber beetle control.
- Cucumber beetles are not always present.
- Cucumber beetles are not efficient vectors of the bacterium.
- Sampling can be accomplished with yellow sticky traps.

Established Thresholds (direct counts):

- 1 beetle / plant for melons, cucumbers, and young pumpkins
- 5 beetles / plant for watermelon, squash, and older pumpkins
General Approaches Taken to Manage Insects that Attack Vegetable Crops – IPM Tactics

Managing Vegetable Insect Pests

- Chemical Control
- Plant Resistance
- Behavioral Control
- Cultural Control
- Biological Control
General Approaches Taken to Manage Cucumber Beetles

- Chemical Control
  - Plant Resistance
  - Cultural Control
  - Behavioral Control
  - Biological Control
Cucumber beetles: Management

Cultural
- Later planting
- Eliminate weeds, weedy edges
  sanitation - pollinators
- Row cover early
- Crop rotation
- Transplants
- Trap crops on plastic mulches

Biological
- None effective

Chemical
- Avoid flowering to protect bees (late afternoon sprays)
- At-plant systemic (nicotinyls), foliar insecticides (pyrethroids, carbaryl), and new technologies (seed trt’s)
Cucumber Beetle: Insecticide Options

bifenthrin, delta-methrin, & zeta-cypermethrin

- Brigade® 2SC, Delta Gold™ 1.5EC, and Mustang Max® EC
- labeled application rates
- caution with non-targets

lambda-cyhalothrin + chlorantraniliprole

- Voliam Xpress (6 – 9 fl oz / acre)

thiamethoxam + chlorantraniliprole

- Durivo (10 – 13 fl oz / acre)
Systemic Neonicotinyl Insecticides

**Beneficial Attributes**

- **Broad spectrum**
  - Cucumber beetles, squash bugs, aphids
- **Flexible**
  - Furrow, drench, foliar
- **Long residual**
  - Rate dependant
  - Excessive rain may impact
- **Low toxicity**
  - Soil applied

**Disadvantages**

- Same chemical class (Group 4 MoA)
- Pollinator impact as foliar applications
# Cucumber Beetle Seed Treatment Trials, AAES 2008

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Insecticide</th>
<th>Rate</th>
<th>Application Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated control</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>clothianadin + imidacloprid</td>
<td>1 mg + 0.33 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>3</td>
<td>clothianadin + imidacloprid</td>
<td>0.75 + 0.25 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>4</td>
<td>clothianadin + imidacloprid</td>
<td>0.375 + 0.125 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>5</td>
<td>clothianadin + imidacloprid</td>
<td>0.187 + 0.063 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>6</td>
<td>thiamethoxam</td>
<td>0.75 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>7</td>
<td>11.0 fl oz / acre</td>
<td>In-furrow</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>row cover + thiamethoxam</td>
<td>0.75 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>9</td>
<td>row cover</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Cucumber Beetle Seed Treatments

- Arranged as RCBD with 4 replicates over plastic
- Weekly counts: 1) cucumber beetles, 2) bacterial wilt, 3) yield and quality

**Pickling varieties ‘Treasure’ (●) and ‘Sassy’ (○)**
**Cucumber Beetle Seed Treatments**

<table>
<thead>
<tr>
<th>Trt No.</th>
<th>Insecticide Treatment</th>
<th>Mean Weekly Beetle / Plant</th>
<th>Mean Percent Bacterial Wilt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>untreated control</td>
<td>2.4 0.2 a</td>
<td>42.5 3.4 a</td>
</tr>
<tr>
<td>2</td>
<td>clothianadin + imidacloprid (1.33 mg)</td>
<td>1.0 0.2 c</td>
<td>18.5 2.9 b</td>
</tr>
<tr>
<td>3</td>
<td>(1.0 mg)</td>
<td>0.9 0.2 c</td>
<td>22.5 1.9 b</td>
</tr>
<tr>
<td>4</td>
<td>(0.5 mg)</td>
<td>1.4 0.1 bc</td>
<td>17.5 4.4 bc</td>
</tr>
<tr>
<td>5</td>
<td>(0.25 mg)</td>
<td>1.8 0.2 b</td>
<td>40.0 3.4 a</td>
</tr>
<tr>
<td>6</td>
<td>thiamethoxam (0.75 mg)</td>
<td>0.8 0.1 c</td>
<td>16.4 2.3 bc</td>
</tr>
<tr>
<td>7</td>
<td>(11.0 fl oz / acre)</td>
<td>0.7 0.1 c</td>
<td>8.0 1.6 d</td>
</tr>
<tr>
<td>8</td>
<td>row cover + thiamethoxam (0.75 mg)</td>
<td>1.0 0.2 c</td>
<td>2.2 2.1 e</td>
</tr>
<tr>
<td>9</td>
<td>row cover</td>
<td>0.9 0.1 c</td>
<td>12.5 3.4 c</td>
</tr>
<tr>
<td></td>
<td>Prob F</td>
<td>0.0093</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Acknowledgements

Bill Halfman
A.J. Bussan
Amy Charkowski

Joe Kauffman
Jerry Schneider
Lisa Riniker
Crist Hershberger
Melvin Yoder
Brian Nelson

QUESTIONS?