Integrated Pest Management of Key Insect Pests in Cucurbits: Emphasizing Cucumber Beetles

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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>
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<tr>
<td>Carrot (Proc)</td>
<td>1</td>
<td>4,100</td>
<td>29</td>
<td>$5</td>
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<tr>
<td>Snap beans</td>
<td>1</td>
<td>74,000</td>
<td>35</td>
<td>$31</td>
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<tr>
<td>Peas</td>
<td>2</td>
<td>38,500</td>
<td>21</td>
<td>$19</td>
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<tr>
<td><strong>Minor crops (vine crops)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cucumbers (pickles)</td>
<td>4</td>
<td>6,100</td>
<td>6</td>
<td>$9</td>
</tr>
<tr>
<td>Melon (cantaloupe)</td>
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<tr>
<td>Melon (watermelon)</td>
<td></td>
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<tr>
<td>Melon (honeydew)</td>
<td></td>
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<tr>
<td>Pumpkins</td>
<td></td>
<td></td>
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<tr>
<td>Squash (winter and summer)</td>
<td></td>
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</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.
National Vegetable Production Acres (NASS 2002)
Cucurbit Insect Control

- Insect management:
  - Generally similar insect pests on all
  - Insects may be more severe on some crops and in different geographic regions
Cucurbit IPM

Presentation Outline

➢ Current and Emerging Key Insect Pests:
  ** seed corn maggot
  ** squash bug
  ** squash vine borer
  ** spider mites

➢ Cucumber Beetles and Pollinators
  ** new technologies and implications for conservation
### Calendar of Insect Pests

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
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</table>

- **Squash Bug**
- **Cucumber Beetles**
- **Pickleworm**
- **Squash Vine Borer**
- **Whiteflies**
- **Aphids**
- **Mites**
- **Thrips**
- **Leafminers**
- **Seed maggots**
- **Flea beetles**
Seed corn maggot, *Delia platura*

**Life cycle**

**Adult**
- Small grey/black fly
- Similar to housefly

**Eggs**
- Small, white
- Laid in soil at base of plants

**Larvae**
- White, legless maggots
- 4 instars; up to 1/4”
- 3-4 weeks per generation
- 3-5 generations per year

**Pupa**
- Brown, oval shaped
- In soil
Seed corn maggot, Host range

- Wide host range
- Can develop on organic matter

<table>
<thead>
<tr>
<th>Crop Susceptibility</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucurbits (squash, cucumber, melon)</td>
<td>Peas</td>
<td>Brassica (broccoli, cauliflower)</td>
<td></td>
</tr>
<tr>
<td>Beans (lima, snap)</td>
<td>Beans (soy, kidney)</td>
<td>Corn</td>
<td></td>
</tr>
</tbody>
</table>
Seed corn maggot: Seedling damage

Occurrence

- Overwinter in soil as pupa
- Adults emerge in spring
- 4-5 generations/year. 2nd adult peak in May/June is usually most serious

Damage

- Larvae hatch and tunnel germinating seeds
- Larvae feed in seed and developing plant and prevent emergence or severely distort plant.
- Moderate feeding may injure 1st leaves only giving crop a ragged appearance
- Cool weather, which delays plant emergence increases severity of damage
Seed corn maggot: Management

**Cultural**
- Prevent egg laying with row cover
- Speed up germination:
  - pre-sprout, mulch, warm soil
- Avoid green manure

**Biological**
- Predacious soil beetles
- Fungal epidemics

**Chemical**
- In-furrow, insecticides (neonicotinoids*, bifenthrin)
- Commercial seed treatments (Lorsban 50W)

*Not registered for target
Chlorpyrifos

- Lorsban® 50W
- 2 oz / 100 lb seed
- commercial seed treatments (no on-farm use)
- Incotec, Seed Dynamics

Bifenthrin

- Capture® LFR
- 3.4 – 8.5 fl oz / acre
- in-furrow, banded, or broadcast applications
Squash bug, *Anasa tristis*

**Occurrence**
- Adults are large black bugs which aggregate on plants
- Round eggs are laid in neat rows
- Nymphs are white/grey

**Damage**
- Phytotoxic saliva causes wilting
- Cucurbit yellow vine decline
  - Hubbard and winter squash more severely affected
Squash bug - Management Thresholds

**Seedling Stage**

- Treat if wilting and squash bugs are observed

**Flowering Stage**

- Treat if > 1 egg mass is found per plant

**Control**

- Systemic neonicotinoids*
- Foliar insecticides
- Cultural:
  - sanitation – remove overwintering sites
  - destroy crop residue

*Squash bug egg mass

*Not registered for target
Squash bug: Insecticide Options

- **imidaclopid, thiamethoxam, dinotefuran**
  - Admire® Pro, Platinum® 2SC, Venom® 20SG
  - Labeled application rates (in-furrow)

- **zeta-cypermethrin, bifenthrin**
  - Mustang Max® EC, Brigade® 2SC
  - Labeled application rates
  - Caution with non-targets

- **lambda-cyhalothrin + chlorantraniliprole**
  - Voliam Xpress (6 – 9 fl oz / acre)
Two-spotted spider mites, *Tetranychus urticae*

**Occurrence**
- Usually occur in hot dry conditions
- More severe during dusty conditions
- Multiple generations on undersurface of leaf

**Damage**
- Adults feed in large numbers on leaf surface causing “silvering”
- Lower surface often covered with webbing
- Late season pest
- Can be ‘flared’ by pyrethroids
Spider mite, Management

Cultural
- Maintain good plant growth, irrigate
- Avoid excess dust

Biological
- Several effective predators
- Avoid broad-spectrum insecticides

Chemical
- Unless necessary, do not use
- ‘Hormoligosis’: boosts egg production
- Acramite, Agri-Mek, Zeal, M-pede
Two-spotted Spider Mite: Insecticide / Miticide Options

spiromesifen
- Oberon® 2SC
- 7 – 8.5 fl oz / acre
- minimal non-target effects

etoxazole (on melons only)
- Zeal®
- effective ovicide

bifenthrin
- Brigade® 2SC
- 5.1 – 6.4 fl oz / acre
Squash Vine Borer

**Occurrence**

- Adults are diurnal, wasp-like moths
- Lay eggs singly on vines
- Larvae bore into plants and destroy vascular tissues = wilting and death.
- Not a pest of watermelon, muskmelon, or cucumbers
- Emerging issue on winter squash (Hubbard) and pumpkin
- Occasional second generation
Squash Vine Borer Control

**Sampling**
- Field history: past problems = future problems
- Often more serious in smaller plantings
- Pheromone traps; emergence of adults at 1,000 DD$_{50}$
- Direct observation = entrance holes & frass

**Cultural**
- Practice good field sanitation
- destroy residue

**Chemical (re-application)**
- Pyrethroids, pyrethins
- Sevin (XLR), Thiodan
- *Bacillus thuringiensis* var. ‘kurstaki’
Squash Vine Borer: Insecticide Options

**zeta-cypermethrin, bifenthrin**
- Mustang Max® EC, Brigade® 2SC
- labeled application rates
- caution with non-targets

**lambda-cyhalothrin + chlorantraniliprole**
- Voliam Xpress (6 – 9 fl oz / acre)

**Note: directed application to the first 12-16” of vine; ‘post-chicory bloom’.**
**A3688 (http://www.uwex.edu/ces/pubs)**
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
Cucumbers 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*, which is 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
- Cultural Control
- Behavioral Control
- Biological Control
General Approaches Taken to Manage Cucumber Beetles

Chemical Control

Plant Resistance

Behavioral Control

Cultural 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)

Row cover and seed treatment experiments, AAES 2008
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></td>
<td>0.75 + 0.25 mg a.i. / seed</td>
<td>Seed</td>
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<tr>
<td>4</td>
<td></td>
<td>0.375 + 0.125 mg a.i. / seed</td>
<td>Seed</td>
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<tr>
<td>5</td>
<td></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>
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<tr>
<td>7</td>
<td></td>
<td>11.0 fl oz / acre</td>
<td>In-furrow</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>
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</tbody>
</table>
Cucumber Beetle Seed Treatments

- Arranged as RCBD with 4 replicates over plastic
- Weekly counts: 1) cucumber beetles, 2) bacterial wilt
- 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>
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<td>Prob F</td>
<td>0.0093</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Insects Impact Cucurbit Production

Pollinators...

...and Devastators

European honey bee

Striped cucumber beetle
Factors Harming Honey Bee Populations

- **Insecticides:**
  - Do not apply to crops in bloom
  - Application timing: apply in the late afternoon or early evening
  - Choose short residual products
  - Adjust spray to weather conditions
    - **low temps extend residual**
    - **protract foraging times**
  - Application formulation (s):
    - EC > WP, WSP, D
Can we rely on honey bees to pollinate cucurbit crops?

American Farmland Trust's, 2008 FQPA EPA Region 5 Grant Program

“Sustainable Management Solutions for the Cucumber Beetle – Bacterial Wilt Pathosystem in Wisconsin”
Influence of Agricultural Practices on Populations of Native Bees

- To identify the most common native bee species that visit and pollinate cucurbit flowers

- Determine periods during season that dominant bee species are most and least prevalent

- To determine how different types of farming practices and pest management practices affect populations of the most common native bee species
Acknowledgements

Bill Halfman
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Brian Nelson

QUESTIONS?

Wisconsin Fresh Market
Vegetable Growers Association