New Options for Cucumber Beetle Control in Cucurbit Crops: Review of Corn Earworm / Tomato Fruitworm Management

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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>
<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>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melon (watermelon)</td>
<td></td>
<td></td>
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<td></td>
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<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>
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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.
Insect management:

- Generally similar insect pests on all
- Insects may be more severe on some crops and in different geographic regions
## 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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aphids</td>
<td></td>
<td>Pickleworm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cucumber Beetles</td>
<td></td>
<td>Squash Bug</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Squash Vine Borer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Whiteflies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flea beetles</td>
<td></td>
<td>Thrips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leafminers</td>
<td></td>
<td>Seed maggots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Aphids</td>
<td>Mites</td>
<td></td>
</tr>
</tbody>
</table>

- **April:** Flea beetles, Leafminers, Seed maggots
- **May:** Aphids, Cucumber Beetles
- **June:** Squash Bug, Squash Vine Borer, Pickleworm, Flea beetles
- **July:** Whiteflies, Thrips
- **August:** Mites, Aphids
- **September:** Cucumber Beetles
- **October:** Sausage Bug, Squash Vine Borer, Pickleworm, 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>Beans (soy, kidney)</td>
<td>Corn</td>
</tr>
<tr>
<td>Beans (lima, snap)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brassica roots (radish)</td>
<td>Brassica (broccoli, cauliflower)</td>
<td></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
Seed corn maggot: Insecticide Options

**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

imidacloprid, 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
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
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*, 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

- Chemical Control
- Plant Resistance
- Behavioral Control
- Cultural Control
- Biological Control

Managing Vegetable Insect Pests
General Approaches Taken to Manage Cucumber Beetles

- Chemical Control
- Plant Resistance
- Behavioral Control
- Cultural Control
- Biological Control

Managing Cucumber Beetles
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: New 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)
‘Relatively New’ 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>(Sepresto®)</td>
<td>0.75 + 0.25 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.375 + 0.125 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<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 (Cruiser® 5FS)</td>
<td>0.75 mg a.i. / seed</td>
<td>Seed</td>
</tr>
<tr>
<td>7</td>
<td>(Platinum® 2SC (75SG))</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>
</tr>
</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</td>
<td>42.5</td>
</tr>
<tr>
<td>2</td>
<td>clothianadin + imidacloprid (1.33 mg)</td>
<td>1.0</td>
<td>18.5</td>
</tr>
<tr>
<td>3</td>
<td>Sepresto® (1.0 mg)</td>
<td>0.9</td>
<td>22.5</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1.4</td>
<td>17.5</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1.8</td>
<td>40.0</td>
</tr>
<tr>
<td>6</td>
<td>thiamethoxam (Cruiser® 5FS) (0.75 mg)</td>
<td>0.8</td>
<td>16.4</td>
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<tr>
<td>7</td>
<td>Platinum® 2SC (11.0 fl oz / acre)</td>
<td>0.7</td>
<td>8.0</td>
</tr>
<tr>
<td>8</td>
<td>row cover + thiamethoxam (0.75 mg)</td>
<td>1.0</td>
<td>2.2</td>
</tr>
<tr>
<td>9</td>
<td>row cover</td>
<td>0.9</td>
<td>12.5</td>
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<tr>
<td></td>
<td><strong>Prob F</strong></td>
<td><strong>0.0093</strong></td>
<td><strong>&lt;0.0001</strong></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?

“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
Tomato Insect Pests

**Common Pests**
- Tomato fruitworm
- Tomato hornworm
- Potato aphid
- Cutworms - armyworms
- Thrips

**Intermittent Pests**
- Flea beetles
- Whiteflies
- Two-spotted spider mites
- Colorado potato beetle
- Vegetable leafminer

![Tomato hornworm](image1)

![Tomato fruitworm](image2)
Calendar of Tomato Insect Pests

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spider mites</td>
<td>Tobacco thrips</td>
<td>Potato and Green Peach Aphids</td>
<td>Western flower thrips</td>
<td>Whiteflies</td>
<td>Stink bugs</td>
<td>Flea beetles</td>
<td>Flea beetles</td>
</tr>
</tbody>
</table>
Phenology of Insect Infestations

- Early season – planting to 1st flower
  - Flea beetles
  - Tobacco thrips
  - Potato aphids
Flea Beetles as Tomato Pests

Flea beetle (several species)

Appearance
- Small, shiny black beetles
- Hind legs enlarged for jumping
- Overwinter as adults
- 2 generations per year

Damage
- Adults chew small circular holes
- Can kill small plants
- Larvae in soil are not damaging
Flea Beetle Management

**Cultural**
- Exclude adults with row cover
- Attract adults to alternate trap crop (Indian mustard)
- Avoid early planting

**Biological**
- No effective controls

**Chemical**
- Spray to control adults (carbaryl, synthetic pyrethroids)
- DO NOT disrupt biological controls of other pests (aphids)
- Neonicotinoid insecticides
Thrips

- 4 narrow, fringed wings
- Tube-like mouthparts
- Virus vectors (TSWV & INSV)

Thrips Damage

- Rasping mouthparts puncture plant surfaces.
- Egg-laying also damages plants.
- Injury appears in streaks rather than spots ‘silvering’.
- Buds fail to open.
Thrips Damage – Virus Infection

Tomato spotted wilt virus (TSWV)

Impatiens necrotic spot virus (INSV)
Aphids

- Soft-bodied insects
- Wings present or absent
- Cornicles (tail pipes)
- Honeydew – Sooty mold
- May transmit viruses
- Reduces plant vigor, stunting, malformation
Aphid Monitoring

- Check as many plants as possible
- Look at terminal buds and lower leaf surfaces
- Cast skins, honeydew, & sooty mold are indications of aphid infestation.
- Yellow sticky traps can monitor winged aphids
Aphid IPM

- **Sanitation**
  - Remove alternate hosts (weeds)
- **Limit the use of quick-release fertilizer**
- **Beneficial Insects**
  - Green lacewings
  - Ladybeetles
  - Parasitic wasps
Aphid Chemical Control

- Rotate chemicals every 2-3 applications to prevent insecticide resistance
- Organophosphate resistance common

AdmirePro / Marathon - drench better
Fulfill / Endeavor - slow kill-but stop feeding fast

Orthene 95
Agri-Mek 0.15EC

Azatin, Beauvaria bassiana (Botanigard)
2009 New Insecticide Registrations

- **dinotefuran (Venom® 75SG):** aphids, thrips, whiteflies
  - 1 – 4 oz / A (foliar)
  - 5 – 6 oz / A (soil-applied)

- **bifenthrin + imidacloprid (Brigadier®):** whiteflies
  - 3.8 – 9.9 fl oz / A (foliar)

- **flonicamid (Beleaf® SG):** aphids
  - 2 – 2.8 fl oz / A (foliar)

- **lambda-cyhalothrin + chlorantraniliprole (Voliam Xpress®):**
  - 6 – 9 fl oz / A (foliar)

- **thiamethoxam + chlorantraniliprole (Durivo®):** aphids, thrips, whiteflies
  - 10 – 13 fl oz / A (soil-applied – drip system)

- **spirotetramat (Movento®):** aphids, thrips, whiteflies
  - 4 – 5 fl oz / A (foliar)
Tomato Fruitworm (corn earworm)

**Adult**
- Does not overwinter
- Adults migrate from the south
- 2 generations / year

**Eggs**
- Laid singly on leaves
- Hatch in 5-7 days
- Feed externally on leaf and then bore into fruit

**Larvae**
- Develop inside fruit
- Brownish or green in color (morphs)
**Tomato Fruitworm Damage**

**Occurrence**
- 2\textsuperscript{nd} generation only – Aug/Sept

**Damage**
- Small larvae feed on leaves
- Larger bore into fruit
- Develop internally
- Infested fruit may color early or rot
- Major pest in CA and FL
Tomato Fruitworm Monitoring and Control

**Cultural**
- Plant early: avoidance in time
- Discard infested fruit

**Biological**
- Effective parasites
- But will not prevent damage

**Chemical**
- Rarely necessary
- Disrupts natural control of other pest (leaf miner, aphid)

Insect Migration Risk Forecast
Northern Illinois University
# Fruitworm Insecticides

<table>
<thead>
<tr>
<th>Pyrethroids</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asana</td>
<td>Avaunt</td>
</tr>
<tr>
<td>Baythroid</td>
<td>Proclaim</td>
</tr>
<tr>
<td>Brigade</td>
<td>Radiant, SpinTor, <strong>Entrust</strong></td>
</tr>
<tr>
<td>Danitol</td>
<td><em>Bacillus thuringiensis</em></td>
</tr>
<tr>
<td>Mustang Max</td>
<td>(Dipel, Javelin)</td>
</tr>
<tr>
<td>Warrior</td>
<td></td>
</tr>
<tr>
<td><strong>Pyganic, Evergreen</strong></td>
<td></td>
</tr>
</tbody>
</table>

**New registrations in 2008:**

- *rynaxypyr (Coragen®)*
  - 3.5 – 5.0 fl oz / A (foliar)
- *flubendiamide (Synapse® WG)*
  - 2.0 – 3.0 oz / A (foliar)
Considerations when Choosing an Insecticide for Fruitworm Control

- Other insects present
  - Stink bug
  - Armyworms
- Effect of Insecticides on potential pests
  - Twospotted spider mite
- Preharvest Interval (PHI)
Conclusions

• Preplant or at planting use of Admire or Platinum will control key insect pests to flowering/first fruit set.

• Insecticide selection decision after first flower
  – Fruitworm control is paramount
  – Early detection of cutworm, armyworm, whitefly, stinkbug and two-spotted spider mites are also important to adjust pesticide program to avoid/cure problem.
Acknowledgements

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Brian Nelson

QUESTIONS?

Wisconsin Fresh Market
Vegetable Growers Association