Using Novel Insecticides: Pest Spectrum and Delivery Options

Illinois Specialty Crops, Agritourism and Organic Conference
January 12, 2012

Russell L. Groves
Department of Entomology
University of Wisconsin
1630 Linden Drive
Madison, WI  53719
groves@entomology.wisc.edu
### Wisconsin Vegetable Production Statistics (Wis. Ag. Stats. 2008)

<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>3</td>
<td>64,500</td>
<td>6</td>
<td>$242</td>
</tr>
<tr>
<td>Sweet corn (Proc)</td>
<td>1</td>
<td>88,900</td>
<td>21</td>
<td>$81</td>
</tr>
<tr>
<td>Sweet corn (Fresh)</td>
<td>--</td>
<td>7,700</td>
<td>--</td>
<td>$14</td>
</tr>
<tr>
<td>Snap beans</td>
<td>1</td>
<td>82,300</td>
<td>38</td>
<td>$62</td>
</tr>
<tr>
<td>Peas</td>
<td>3</td>
<td>40,200</td>
<td>21</td>
<td>$20</td>
</tr>
<tr>
<td><strong>Minor crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumbers (pickles)</td>
<td>4</td>
<td>7,100</td>
<td>8</td>
<td>$9</td>
</tr>
<tr>
<td>Cabbage (fresh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabbage (kraut)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onions (storage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beets (table)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Small-acreage fresh market production continues to expand. Anecdotal statistics estimate ca. 1,900 small-acreage producers that grow over 50 crops in Wisconsin.
Factors Influencing Insect Pest Management
‘Water Quantity and Quality’

• Decreasing availability of water for agriculture
  - Agriculture is the overwhelming user of fresh water.
  - Increasing urban demand will drive irrigation efficiency.

• Drip irrigation, micro-sprinklers, hydroponics.

• Targeted application of water increases opportunity to use irrigation as a delivery system.
Factors Influencing Insect Pest Management
‘Environmental Concerns’

– With increasing affluence reaching the developing world, there will be increasing concerns about pesticide usage and perceived environmental effects.

– This will accelerate the shift to “softer” products and technologies.
Factors Influencing Insect Pest Management

‘Food Safety’

– Major food retailers are setting acceptable residue levels below those set by government regulatory agencies.

“No detectable residues” will be a competitive advantage for food retailers.

– Older insecticides that do not meet these requirements are not being re-registered, resulting in increased use of novel insecticides (bio-pesticides).
Wisconsin Vegetable Pest Management

Options for Insect Pest Management – *More than ever before!*

- Cultural controls
- Host plant resistance
- Transgenic plants
- Reduced-Risk Chemical Insecticides
- Natural enemies
- Population disruption
- Entomopathogens
- Baits and baiting systems
- IR traits
- Vegetable IPM
Components of an IPM Program

- Monitoring and Sampling (inspect)
- Pest Identification (what pest)
- Decision-making (what action(s))
- Intervention (take action (s))
- Follow-up (re-inspect)
- Record-keeping (write it down, history)
- Education (learn)
What IPM is NOT!

- IPM does **NOT** preclude the use of pesticides!

- IPM is **NOT** merely a biological or “organic” pest control program

- IPM is a decision-making process, **NOT** a stringent or rigid management regime
Insect Management in Potatoes - Key Pests -

- Colorado potato beetle
- Green peach aphid
- Potato leafhopper
Colorado potato beetle adult
-> Overwintering site
-> Close to last crop
-> Adults 6” to 12” deep
-> Protected by mulch
Adults lay eggs on underside of leaves

- Yellow / orange

- 20-40 eggs/mass
Small larvae feed in terminals

4 instars, 5-7 days/stage

Large larvae (3+4) feed extensively
4th instar larva
Pupae in soil

2-3 weeks

Summer adults emerge (July)
Summer adults emerge in July

- Very active
- Very hungry
Colorado potato beetle ecology

Management on crop
- Prediction
- Timing
- Resistance

Infesting crop
- Trap crops
- Trenches
- Physical control

Finding crop
- Crop rotation
- Cover crops
- Disrupt dispersal

Leaving crop
- Trap crops
- Physical control

Adult diapause
- Habitat disruption
- Cold shock
Colorado Potato Beetle Dispersal / Crop Colonization
Perimeter Insecticide / Edge Treatments

Diagram showing the treatment areas with dates for April 25, May 2, May 9, and May 16.
Trap adults moving into crop

Beetle Trench

Overwintering Site

Walking Beetles
CPB Trenching / Edge Treatments

- Trapping overwintered, adult CPB walking into fields.
Biological Controls

† Predators, parasites exist but rarely effective
Must control first generation in June

Ignore overwintered adults unless severe feeding

Target young larvae, 1\textsuperscript{st} and 2\textsuperscript{nd} instar

Look for egg hatch

5 to 10 days, depending on temperature
**Problem:** beetle has developed resistance to many insecticides e.g. carbamates, organophosphates,

**Tools available**

*Reduced-Risk & Biological (specific)*

- **Spinosad (Entrust=OMRI)**
  - Target 1\textsuperscript{st}, 2\textsuperscript{nd} generations
  - 1-2 applications only

- **Neonicotinoids (Admire Pro, Platinum)**
  - At – plant applications
  - 8 – 10 weeks of control (!!!!!!)
Systemic Neonicotinyl Insecticides

**Beneficial Attributes**
- Effective on pyrethroid resistant CPB’s
- Broad spectrum
  - CPB, leafhoppers, aphids
- Flexible
  - Row mark, furrow, seed, layby
- Long residual
  - Rate dependant
- Low toxicity
  - “Healthy Grown”

**Disadvantages**
- Same chemical class
- Resistance likely
Colorado Potato Beetle Management Development and Defoliation Thresholds

- At-plant systemic insecticide
- Reduced-risk foliar applications – 2nd generation

Development threshold = 1st and 2nd instar stadia

Need to protect potato crop from CPB for 6-8 weeks

At-plant systemic

Planting

1st Gen CPB

RR-Foliar

2nd Gen CPB

Vine Kill

Potato Crop

Sexson and Wyman (2005)

- 20% Defoliation (pre-flower) and < 10-15% (post-flower)

- Population Development Thresholds (eggs, larvae)

Development threshold = 1st and 2nd instar stadia

Need to protect potato crop from CPB for 6-8 weeks


Planting RR-Foliar RR-Foliar RR-Foliar 1st Gen CPB 2nd Gen CPB Potato Crop Vine Kill

Colorado Potato Beetle Management Development and Defoliation Thresholds
Reduced Risk Foliar Options (CPB)

- **Radiant™ (spinetoram)**
  - MoA group 5
  - Use rate 4.5 – 8 fl oz / a (CPB)
  - Control of CPB, early & late larvae and Leps

- **Rimon 0.83 EC (novaluron):**
  - Chitin biosynthesis inhibitors (MoA Group 15)
  - Use rate 9 – 12 fl oz / ac (foliar)
  - Control of CPB larvae only, and Leps
  - Timing critical (80% egg deposition - 20% egg hatch)

- **Agri-Mek 0.7SC & 0.15EC (abamectin):**
  - Chloride channel activator (MoA Group 6)
  - Use rate 8 – 16 fl oz / ac (foliar)
  - Control of CPB larvae only
  - Temprano, Abba, Athena
Reduced Risk Foliar and In-Furrow Options (CPB) New Registrations

- **Coragen™ (rynaxypyr)**
  - Anthranillic diamide (MoA group 28)
  - Use rate 3.5 – 5.0 fl oz / ac
  - Control of CPB adults and larvae and Leps

- **DPX-HGW86 (cyazypyr)**
  - Anthranillic diamide (MoA group 28)
  - Use rate 6.5-13.5 fl oz / ac (OD foliar)
  - Control of CPB adults and larvae, leafhoppers, aphids, and Leps

* Water soluble, systemically mobile insecticides
** Not currently registered
Potato leafhopper

**Appearance**
- Adults, small (1/8”) wedge-shaped, bright green
- Rapid movement
- Nymphs, yellow-green, lack wings

**Occurrence**
- Does not overwinter in Wisconsin
- Adults migrate from gulf states
- Arrive June, 2-3 generations/year
- Very broad host range includes potatoes, beans, alfalfa
- Can infest quickly
Potato leafhopper - damage

- Both adults and nymphs feed
- Sucking mouthparts
- Saliva clogs plant, causes yellowing, leaf necrosis
- Can kill young plants quickly
- May only cause stunting

Treated with insecticides
Potato Leafhopper - damage
# PLH Management

<table>
<thead>
<tr>
<th>Cultural</th>
<th>Biological</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Plant early to avoid</td>
<td>- No effective biologicals</td>
</tr>
<tr>
<td>- Varietal selection (e.g. Yukon Gold)</td>
<td></td>
</tr>
<tr>
<td>- Row cover</td>
<td></td>
</tr>
</tbody>
</table>

**Chemical**
- Monitor often (June 1)
- Treat only when threshold exceeded (1/sweep)
- Do not let nymphs build up
- Control is effective if needed:
  - pyrethrum (e.g. Pyganic)
  - azadirachtin (Neem-based products)
# 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>Squash Bug</td>
<td>Cucumber Beetles</td>
<td>Pickleworm</td>
<td>Squash Vine Borer</td>
<td>Whiteflies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aphids</td>
<td>Mites</td>
<td>Thrips</td>
<td>Thrips</td>
<td>Leafminers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seed maggots</td>
<td>Flea beetles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Seed corn maggot, *Delia platura*

**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: Seedling damage

**Occurrence**
- Overwinter in soil as pupa
- Adults emerge in spring
- 4-5 generations/year. 2\textsuperscript{nd} 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 1\textsuperscript{st} 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)
- Commercial seed treatments (Entrust)
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**

- Foliar insecticides (pyrethrum)
- Cultural:
  - sanitation – remove overwintering sites
  - destroy crop residue

*Squash bug egg mass

*Not registered for target
**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)**
- Pyrethrum (Pyganic)
- *Bacillus thuringiensis* var. ‘kurstaki’
Squash Vine Borer: Insecticide Options

**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
Management – Bacterial Wilt

• Avoidance of bacterial wilt is accomplished through effective cucumber beetle control.

• 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
Managing Cucumber Beetles

General Approaches to Managing Cucumber Beetles

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

Cultural
- Later planting (June 10 – 15)
- Transplants
- Trap crops on plastic mulches
Cucumber beetles: Management

Cultural
- Eliminate weeds, weedy edges (sanitation) – pollinators
- Crop rotation
- Early season row cover

Close mowing
Row cover
Floral Nectaries
Established Thresholds (based on bacterial wilt susceptibility):
- 1 adult beetle / plant (cantaloupe, muskmelon, & cucumber)
- 5 adult beetles / plant (watermelon, squash, & older pumpkins)

Cucumber Beetle Management At Threshold

Need to protect cucurbit crop from beetles for 4-6 weeks??

At-plant systemic ($6-8 / A)

Striped cucumber beetle

Cucurbit Crop

Planting

Harvest
Established Thresholds (based on bacterial wilt susceptibility):

- 1 adult beetle / plant (cantaloupe, muskmelon, & cucumber)
- 5 adult beetles / plant (watermelon, squash, & older pumpkins)

Need to protect cucurbit crop from beetles for 4-6 weeks??

Foliar Neonicotinoid ($22-28 / A)

Striped cucumber beetle

Planting → Row cover → Cucurbit Crop → Harvest

Insects Impact Cucurbit Production

Pollinators...

European honey bee

...and Devastators

Striped cucumber beetle
Factors Harming Honey Bee Populations

- **Insecticides** (Kevan et al. 1997)
  - 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
Know Your Stink Bug’s

BMSB

GSB

BSB
Identifying the Brown Marmorated Stink Bug

Look for these unique identifying features…

- red eyes & ocelli
- black and white banding
- white banding

Image courtesy of David J. Shetlar
The Ohio State University
Ventral side - light colored; may have black or gray markings

Legs – brown with faint white bands
Brown Marmorated Stink Bug

- Native to Asia (China, Japan, Korea).
- First detected in Allentown, PA, in 1998.
- Wide host range, including tree fruits, many vegetables, soybeans, corn, forest trees, ornamentals, and probably mint.
- Seeks buildings, commonly homes, in the fall as overwintering sites.
- Severe economic losses in mid-Atlantic states in 2010.
- Detected in MN in 2009, IL, MO and NE this past year for the first time.
Current BMSB Distribution in the United States.

Stages of Invasion by Alien Species

Arrival → Establishment → Integration → Spread
Factors Contributing to BMSB Abundance

- **Wide host range**
  - >300 plants are hosts
  - Allows for populations to buildup in many non-managed habitats (woods) or field crops with few insecticide sprays (i.e., soybean)

- **Absence of effective natural enemies**
  - % parasitism in US by native *Trissolcus* spp. <5%
  - % parasitism in China 50-80%

- **Highly mobile and “nervous” insect**
If you see (suspect) a Brown Marmorated Stink Bug…

- Contact your County Extension Educator at [http://www.csrees.usda.gov/Extension](http://www.csrees.usda.gov/Extension/)

- Stinkbugs that are suspected to be the BMSB should be sent for positive identification. Stinkbug samples from Wisconsin will be processed for free at UW; please send stinkbug samples to:
  - Attn: BMSB Reports
  - Phil Pelleterri and Pest Diagnostic Clinic
  - Department of Entomology, Rm. 240
  - 1630 Linden Drive,
  - University of Wisconsin
  - Madison, WI 53706

- DO NOT ship live insects. Please place dead insects in a leak-proof, crush-proof container (e.g., plastic medicine bottle or film canister).

- Additional details regarding submitting insect specimens are available at: [http://www.entomology.wisc.edu/diaglab/entodiag.html#submit](http://www.entomology.wisc.edu/diaglab/entodiag.html#submit)
QUESTIONS?