Insect Pest Management – Vegetable Crops

Wisconsin School for Beginning Market Growers
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http://www.entomology.wisc.edu/vegento
Vegetable IPM Resources

- **Vegetable Insect Mgmt Web-page**
  - [University of Wisconsin Madison Vegetable Crop Entomology](http://www.entomology.wisc.edu/vegento)

- **Vegetable Disease Mgmt Web-page**
  - [UW Vegetable Pathology](http://www.plantpath.wisc.edu/wivegdis)
  - [Wisconsin Pest Bulletin](http://datcpservices.wisconsin.gov/pb/index.jsp)

- **WFFVGA**
  - [Wisconsin Fresh Produce](http://www.wisconsinfreshproduce.org)

- **Wisconsin Pest Bulletin**
  - [Wisconsin Pest Bulletin](http://datcpservices.wisconsin.gov/pb/index.jsp)
Presentation Outline

- Integrated Pest Management

- 3 Vegetable Crop / Insect Combinations
  - Potato
  - Onion
  - Cucurbits

- Exotic Invader
  - Brown Marmorated Stinkbug (BMSB)
National Vegetable Production Acres (NASS 2002)
### Total Impact of Specialty Crop Production and Processing

*(Economic activity in $ millions per year)*

<table>
<thead>
<tr>
<th>Industry</th>
<th>Total Economic Activity</th>
<th>Total Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable &amp; Fruit Production</td>
<td>$1,092</td>
<td>9,900</td>
</tr>
<tr>
<td>Potatoes</td>
<td>$349</td>
<td>2,770</td>
</tr>
<tr>
<td>Cranberries</td>
<td>$300</td>
<td>3,400</td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>$83</td>
<td>660</td>
</tr>
<tr>
<td>Green Beans</td>
<td>$63</td>
<td>490</td>
</tr>
<tr>
<td>Green Peas</td>
<td>$26</td>
<td>200</td>
</tr>
<tr>
<td>Carrots, Cucumbers &amp; Onions</td>
<td>$28</td>
<td>220</td>
</tr>
<tr>
<td>Ginseng</td>
<td>$16</td>
<td>130</td>
</tr>
<tr>
<td>Specialty Crop Processing</td>
<td>$5,268</td>
<td>24,800</td>
</tr>
<tr>
<td><strong>Total Impact</strong></td>
<td><strong>$6,360</strong></td>
<td><strong>34,700</strong></td>
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</tbody>
</table>

*Production estimates based on 2006-2008 average farmgate values; processing estimates based on 2007 Economic Census values. Note: Sum of impacts may not equal total impact due to rounding.*

Keene and Mitchell, 2010
Wisconsin Vegetable Pest Management

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

- **Transgenic plants**
  - IR traits
- **Natural enemies**
- **Cultural controls**
- **Vegetable IPM**
  - Host plant resistance
- **Reduced-Risk Chemical Insecticides**
- **Baits and baiting systems**
- **Population disruption**
- **Entomopathogens**
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
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 and Residues’

– 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 & reduced-risk).
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.
Insect Management in Potatoes
- Key Pests -

Colorado potato beetle

Green peach aphid

Potato leafhopper
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
Infesting crop
• Trap crops
• Trenches
• Physical control

Finding crop
• Crop rotation
• Cover crops
• Disrupt dispersal

Management on crop
• Prediction
• Timing
• Resistance

Colorado potato beetle ecology

Leaving crop
• Trap crops
• Physical control

Adult diapause
• Habitat disruption
• Cold shock
Colorado Potato Beetle Dispersal / Crop Colonization
Perimeter Insecticide / Edge Treatments
Trap adults moving into crop

Beetle Trench

Overwintering Site

Walking Beetles
CPB Trenching / Edge Treatments

- Trapping overwintered, adult CPB walking into fields.
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\(^{st}\), 2\(^{nd}\) generations
  - 1-2 applications only

- **Neonicotinoids (Admire Pro, Platinum)**
  - At – plant applications
  - 8 – 10 weeks of control (!!!!!!!)
Colorado Potato Beetle Management Development and Defoliation Thresholds

- 20% Defoliation (pre-flower) and < 10-15% (post-flower)
- Population Development Thresholds (eggs, larvae)

Development threshold = 1\textsuperscript{st} and 2\textsuperscript{nd} instar stadia

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

Planting 1\textsuperscript{st} Gen CPB RR-Foliar 14-May 14-May 13-Jun 13-Jul 12-Aug 11-Sep 11-Oct

RR-Foliar 2\textsuperscript{nd} Gen CPB Vine Kill


Potato Crop
2012 Was The Warmest Year on Record

Chicago, IL: Jan – June, 2012

Contiguous US: June 2011 – 2012

[Charts and graphs showing temperature data for the given periods.]
...And 2012 Was a Very Dry Year
The insect pest and the crop...

Damage from onion thrips

Protected with insecticides

Not protected

Onion Thrips, *Thrips tabaci* Lindeman
Environmental Conditions

Hot and Dry Conditions, 2012
Biological attributes that make onion thrips a pest

- Short developmental time
- Parthenogenenic (do not need to find a mate)
- Highly mobile
- Wide host range
- Overwinter adjacent to onion
- Capability of developing resistance to insecticides
Onion thrips survival, fecundity, and generation time(s) at varying temperatures

<table>
<thead>
<tr>
<th>Factor</th>
<th>Days</th>
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<tr>
<td></td>
<td>68°F</td>
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<tr>
<td>Survival</td>
<td>47</td>
</tr>
<tr>
<td>Eggs laid/ female</td>
<td>210</td>
</tr>
<tr>
<td>Generation time</td>
<td>48</td>
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Murai (2001)
# Onion thrips population growth

<table>
<thead>
<tr>
<th>Date</th>
<th>Number of Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$68^0 F$</td>
</tr>
<tr>
<td>July 1</td>
<td>1</td>
</tr>
<tr>
<td>July 8</td>
<td></td>
</tr>
<tr>
<td>July 15</td>
<td></td>
</tr>
<tr>
<td>July 22</td>
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<td>August 5</td>
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<td>August 12</td>
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<td>August 19</td>
<td></td>
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<tr>
<td>August 26</td>
<td></td>
</tr>
<tr>
<td>September 2</td>
<td></td>
</tr>
<tr>
<td>Number generations</td>
<td>1</td>
</tr>
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</table>
Onion thrips: Management

**Cultural**
- Crop rotation
- Overhead irrigation
- Sanitation (culls & field borders)
- Reflective mulch

**Biological**
- Predacious thrips
- Minute pirate bugs

**Chemical**
- Foliar sprays (Entrust – Aza-Direct)
- Commercial seed treatments (none effective)
**Entrust® SC (spinosad)**

- Macrocyclic lactone (spinosad: MoA group 5)
  - Use rate 1.25 - 2 oz / A
  - Control of onion thrips
- 7-10 days persistence (photostability)
- Very low impact on beneficials
- Low mammalian toxicity

**Aza-Direct®**

- Azadirachtin (MoA group 30 - unknown)
  - Use rate 1 - 2 pts / A (onion thrips)
- 1-3 days persistence (photostability)
- Very low impact on beneficials
- Low mammalian toxicity
Combining Insecticide Sequences and Action Thresholds

Need to protect crop from thrips for 6-8 weeks

1 thrips/leaf

- 15-Mar
- 14-Apr
- 14-May
- 13-Jun
- 13-Jul
- 12-Aug
- 11-Sep
- 11-Oct

1 thrips/leaf

- Thrips
- Onions
- Harvest

- *Entrust
- *Aza-Direct
- *Aza-Direct

Rotating insecticides (classes if possible)
  - e.g., spinosad, azadirachtin

Two successive applications of one product to control a generation

Time applications based on most appropriate threshold (1-3 immature thrips / leaf)

Avoid tank mixing insecticides
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
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)**
- 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](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
General Approaches to Managing Cucumber Beetles

Chemical Control

Plant Resistance

Behavioral Control

Cultural Control

Managing Cucumber Beetles
Cucumber beetles: Management

**Cultural**
- Later planting (June 10 – 15)
- Transplants
- Trap crops on plastic mulches

Blue Hubbard

Black plastic
Cucumber beetles: Management

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

[Images of cultural practices: Close mowing, Row cover, Floral Nectaries]
Cucumber Beetle Management At Threshold

- 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 Pyrethrum (Pyganic®)

Striped cucumber beetle

Planting

Row cover

Cucurbit Crop


Harvest
Brown Marmorated Stink Bug
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**
And new for 2012…

Spotted Wing Drosophila (SWD)

*Drosophila suzukii*

Not (likely) a vegetable pest!!
2012 Distribution of SWD

- Initially detected in 2010 (Racine Co.)
- Not supposed to overwinter in WI??
- Appears in mid to late summer and has many generations in a growing season
Will SWD establish in Wisconsin?

Climex model Damus (2009)
Canadian Food Inspection Agency
What are spotted wing drosophila?
SWD Identification - larvae

Non *Drosophila* Larvae

*Drosophila* Larvae
SWD Monitoring and Sampling

New lure (ACV or *yeast* & *sugar slurry*) + 1 drop unscented dish soap/week

10 1/4” holes

http://www.ipm.msu.edu/invasive_species/spotted_wing_drosophila/monitoring
SWD principally a fruit pest

- Oviposition preferences for raspberry, blackberry, blueberry, cherry and strawberry
- Limited impacts on apples and grapes
- Reports of infestations in ripe tomato and tomatillo (CA)
Access to fruit with saw-tooth ovipositor
If you see (suspect) a BMSB or SWD...

- Contact your County Extension Educator at http://www.csrees.usda.gov/Extension/

- Stinkbugs and maggots that are suspected to be the BMSB or SWD should be sent for positive identification. Samples from Wisconsin will be processed for free at UW; please send 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
University of Wisconsin-Madison

Vegetable Crop Entomology

Extension and Research

http://www.entomology.wisc.edu/vegento