Integrated Pest Management – What’s Bugging You
February 25, 2013

Russell L. Groves
Department of Entomology
University of Wisconsin
1630 Linden Drive
Madison, WI 53719
groves@entomology.wisc.edu

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

- Integrated Pest Management

- 3 Vegetable Crop / Insect Combinations
  - Potato – Colorado Potato Beetle
  - Onion – Root maggots and Onion thrips
  - Brassica – Worm complex

- Hoop House Pests
  - Aphids, thrips, whiteflies, and new tools for delivery
Wisconsin Vegetable Pest Management

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

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

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)
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.
# 2012 Was The Warmest Year on Record

**Chicago, IL: Jan – June, 2012**

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Contiguous US: June 2011 – 2012**

![Graph showing temperature trends for 2012 and comparison with previous years.](chart.png)
...And 2012 Was a Very Dry Year
Where did all these bugs come from and where might they be going?

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
Finding crop
- Crop rotation
- Cover crops
- Disrupt dispersal

Infesting crop
- Trap crops
- Trenches
- Physical control

Management on crop
- Prediction
- Timing
- Resistance

Leaving crop
- Trap crops
- Physical control

Adult diapause
- Habitat disruption
- Cold shock

Colorado potato beetle ecology

- March (Mar)
- April (Apr)
- May (May)
- June (Jun)
- July (Jul)
- August (Aug)
- September (Sep)
- October (Oct)
- November (Nov)
- December (Dec)
- January (Jan)
Colorado Potato Beetle Dispersal / Crop Colonization
Perimeter Insecticide / Edge Treatments
Trap adults moving into crop
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, **1st** and **2nd** instar

Look for egg hatch

5 to 10 days, depending on temperature
Chemical Control

** 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 (!!!!!)
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

Target Pests: Seed Maggot

Onion Maggot
*Delia antiqua*

Seed corn Maggot
*Delia platura*

Maggot Damage
Seed maggots: 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

- Tunnel germinating seeds
- Severely distort plant.
- Cool weather, delays plant emergence increases severity

Wisconsin Damage Calendar

http://datcpservices.wisconsin.gov/pb/index.jsp
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, FarMore DI500, Sepresto)
<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Company</th>
<th>Active Ingredient for OM</th>
<th>Chemical Class (IRAC(^2) group)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diazinon AG500</td>
<td>Makhteshim</td>
<td>diazinon</td>
<td>OP (1)</td>
<td>Pre-plant broadcast &amp; incorporate</td>
</tr>
<tr>
<td>Diazinon 50WP Etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lorsban 4E, 75WG, Advanced</td>
<td>Dow AgroSciences (Lorsban), other companies</td>
<td>Chlorpyrifos</td>
<td>OP (1)</td>
<td>At planting in-furrow, Post-planting banded spray over row</td>
</tr>
<tr>
<td>and OLF(^1)</td>
<td>for OLF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigard</td>
<td>Syngenta</td>
<td>Cyromazine</td>
<td>Triazine (17)</td>
<td>Seed treatment</td>
</tr>
<tr>
<td>Sepresto</td>
<td>Bayer Crop Sciences</td>
<td>Clothianidin + imidacloprid</td>
<td>Neonicotinoid (4) + Neonicotinoid (4)</td>
<td>Seed treatment</td>
</tr>
<tr>
<td>FarMore FI500</td>
<td>Syngenta</td>
<td>Thiamethoxam + spinosad</td>
<td>Neonicotinoid (4) + Spinosyn (5)</td>
<td>Seed treatment</td>
</tr>
</tbody>
</table>

OLF: other labeled formulation such as Warhawk. \(^2\)IRAC: Insecticide resistance action committee
The insect pest and the crop...

Damage from onion thrips
Protect with insecticides

Not protected

Adult

Larva

Onion Thrips, *Thrips tabaci* Lindeman
Environmental Conditions

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

- Short developmental time
- Parthenogenic (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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>68°F</td>
</tr>
<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>
</tr>
</tbody>
</table>

Murai (2001)
# Onion thrips population growth

<table>
<thead>
<tr>
<th>Date</th>
<th>Number of Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$68^0 \text{ F}$</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>
<td></td>
</tr>
<tr>
<td>July 29</td>
<td></td>
</tr>
<tr>
<td>August 5</td>
<td></td>
</tr>
<tr>
<td>August 12</td>
<td></td>
</tr>
<tr>
<td>August 19</td>
<td></td>
</tr>
<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>
</tbody>
</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)
Reduced Risk Foliar Options
New Registration 2006 - Organic

- **Entrust® SC (spinosad)**
  - Macroyclic 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

Onions

Planting


Harvest

Thrips

*Entrust
*Aza-Direct
*Aza-Direct

1 thrips / leaf
Insecticide Control Options

- Rotate 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
Striped cucumber beetle

(\textit{Acalymma vittatum})
Cucumber Beetles: Damage

- Defoliation
- Pollination Interference
- Feeding Scars
- Rindworms
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
Cucumber beetles: Management

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

![Image of cucumber field with Black plastic mulch and Blue Hubbard cucumber]
Cucumber beetles: Management

Cultural
- Eliminate weeds, weedy edges (sanitation) – pollinators
- Crop rotation
- Early season row cover
Cucumber Beetle Management At Threshold

- Established Thresholds (based on bacterial wilt susceptibility):
  - 1 adult beetle / plant (canteloupe, muskmelon, & cucumber)
  - 5 adult beetles / plant (watermelon, squash, & older pumpkins)

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

- Foliar Pyrethrum (Pyganic®)
- Harvest
Cole Crops - Insect Pest Complex

Diamond back moth

Imported cabbage worm

Cabbage looper

Sporadic Pests

Cabbage maggot

Flea beetle

Cabbage aphid
Managing Insects on Cole Crops

Excellent example of potential for biological control (Mahr et. al. NCR Regional pub. 471)

History of problem

- Direct damage to marketable product by key pests
  - Worms on heads
  - Maggots on roots
- Multiple insecticide applications used
- Resistance developed as threat to production

Solution

- IPM implementation based on biological control of key pests
- Pesticides switched to specific, ‘soft’ materials to preserve natural control
Diamondback moth life cycle

**Adult**
- Small night flyer, short fast flights
- \(\frac{1}{2}\)”, wings have diamond pattern
- Can monitor with pheromone trap

**Eggs**
- Small, hard to see
- Laid close to veins

**Larvae**
- 4-5 instars up to \(\frac{3}{4}\)” long
- 2-3 weeks
- Cigar shaped, pointed at ends
- ‘wiggle’ when touched
- Spin thread and hang

**Pupa**
- Usually on underside of leaves
- Neatly spun pupal case
Diamondback moth

**Occurrence**
- Does not overwinter in Wisconsin
- Blown in on wind or imported on plants
- 4-8 generations per year

**Damage**
- ‘Window pane’ feeding, may also deform heads
- 1\textsuperscript{st} instar mine in leaf
- Damage usually early-mid season (June/July)
- Resistance to many insecticides
- Major problem worldwide
Imported Cabbage Worm life cycle

**Adult**
- White, day flying butterfly

**Eggs**
- Laid single on undersurface
- White, turning yellow at hatch
- Cigar shaped

**Larvae**
- 5 instars; 3-4 weeks
- Velvety green with yellow dorsal line
- Slow moving
- Up to 1 ½ inches in length

**Pupa**
- Distinctive angular shape
- Usually on plant debris/old leaves
Imported Cabbage Worm

**Occurrence**
- Overwinters as pupae in Wisconsin
- 3 generations per year, 1st on weeds

**Damage**
- Usually most damaging species in Wisconsin
- Large holes in leaves and heads
- Often extensive frass
- Peak damage mid-season
  (June/July)
Cabbage Looper life cycle

**Adult**
- Large, night flying moth
- Hour glass marks

**Eggs**
- Laid singly on undersurface
- White, turning tan at hatch
- Round shaped

**Larvae**
- 5 instars; 4-5 weeks
- Green with white stripe
- Loop when moving
- Up to 2 inches in length

**Pupa**
- Roughly spun silk cocoon
- Underside of old leaves or on debris
Cabbage Looper

**Occurrence**
- Does not overwinter, adults blow in (June/July)
- 2 generations per year, persisting in late season

**Damage**
- Damage usually late season
- Extensive leaf holes and head damage
Managing the Caterpillar Complex

**Cultural**
- Use clean transplants

**Biological**
- Good complex of parasites
  - Diamondback moth: (70-90%)
  - Imported Cabbage worm: (30-60%)
  - Cabbage looper: (10-30%)
- Multiple species
Managing the Caterpillar Complex

Chemical

Pest Specific

Bacillus thuringiensis (Kurstaki; Btk, or Azaiwi; Bta)
  • Many materials registered
e.g. Dipel, Thuricide, Biobit, Cutlass, etc.
  • Short persistence ➔ timing critical
  • Stomach poison ➔ coverage important
  • Weak on looper

Spinosad (Entrust)

Broad Spectrum

Pyrethroids
  • Multiple applications
  • Resistance can be a problem
  • Eliminate biological controls
## Pest Specific Insecticides for Key Pests

- Control caterpillar pests at thresholds when needed
- Conserve beneficial organisms
- Btk or spinosad

<table>
<thead>
<tr>
<th>Crop</th>
<th>Growth stage</th>
<th>Threshold (% infestation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Seed bed</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Transplant-cupping</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Cupping-early head</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Mature head</td>
<td>10%</td>
</tr>
<tr>
<td>Broccoli/cauliflower</td>
<td>Seed bed</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Transplant-first curd</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Curd present</td>
<td>10%</td>
</tr>
</tbody>
</table>
Hoop houses can be ideal for the build-up of pest populations.
Insects in hoop houses are difficult to manage

- Multiple generations - up to 12-15 / year
- Limited natural enemies to reduce populations
- Almost unlimited food
- More consistent / constant environmental conditions
- Some life stages are not susceptible to treatment
- Major insecticide and miticide resistance
Vegetable IPM Resources

- Vegetable Insect Mgmt Web-page
  
  University of Wisconsin Madison
  Vegetable Crop Entomology
  Extension and Research

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

- Vegetable Disease Mgmt Web-page

  UW Vegetable Pathology
  University of Wisconsin Madison
  Department of Plant Pathology

  http://www.plantpath.wisc.edu/wivegdis

- Wisconsin Pest Bulletin

  http://datcpservices.wisconsin.gov/pb/index.jsp