The Year of the Insect – And Looking Ahead to 2013

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

Presentation Outline

- Integrated Pest Management
- 3 Vegetable Crop / Insect Combinations
  - Striped cucumber beetles - cucurbits
  - Onion thrips and Root maggots - onions
  - Flea beetles – cole crops & fruiting vegetables
  - Squash bugs - cucurbits
- Exotic and Invasive Insect Pests - 2012
  - Brown marmorated stink bug & Spotted wing Drosophila

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)

2012 Was The Warmest Year on Record

- Chicago, IL: Jan – June, 2012
- Contiguous US: June 2011 – 2012

...And 2012 Was a Very Dry Year

- U.S. Drought Monitor
- HYSPLIT air parcel trajectory model

Long Distance Migrations - 2012

- Where did all these bugs come from and where might they be going?
Variegated cutworm, black cutworm, yellow-striped armyworm, fall armyworm, etc…

- Tomatoes, soybeans, alfalfa, potato
- Hostas, petunias, and lots & lots of other things

May 2012

June 2012

Reduced Risk OMRI-Approved Foliar Options

- **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

Reduced Risk OMRI-Approved Foliar Options

- **Bacillus thuringiensis subsp.**
  - (Kurstaki; Btk) – Dipel, Biobit HP, Javelin
  - (Aizawai; Bta) – Agree® WG, Xentari DF

  - Many vendors with registrations
  - e.g. Bonide, Safer, Valent, Certis, Britz-Simplot
  - Short persistence ➔ timing critical
  - Stomach poison ➔ coverage important
  - Btk weak on looper

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
### PLH Management

**Cultural**
- Plant early to avoid
- Varietal selection (e.g. Yukon Gold)
- Row cover

**Biological**
- No effective biologicals

**Chemical**
- Monitor often (June 1)
- Treat only when threshold exceeded (1/sweep)
- Do not let nymphs build up
- Control is effective if needed: organic options (e.g. Pyganic, Aza-Direct)

### Aster yellows

**Disease incidence:**
1%-15% in intensively managed carrot fields

**Variable symptoms:** *Above ground* – leaf yellowing and reddening, twisting, witches’ brooming; *Below ground* – stunted and malformed roots, adventitious root growth

**Other crops affected:** Lettuce, celery, cilantro, canola, parsnip, potato

### Vector: Aster leafhopper (ALH)

**Adult**

- *Macrosteles quadrilineatus* Forbes (Hemiptera: Cicadellidae)
- Approximately 4 mm long and weigh 1 mg (0.8 mg M; 1.2 mg F)
- Light greenish-yellow in color (seasonally variable)
- Widely distributed in the U.S.

**Immature**

### Aster yellows phytoplasma (AYp), *Ca. phytoplasma asteris*

Small (0.4 μm diameter), wall-less prokaryotic organism of the provisional genus *Candidatus*

Infects > 350 species in 38 plant families

Obligately associated with host (insect and plant) and not mechanically transmissible

### Plant-to-plant transmission of AYp

<table>
<thead>
<tr>
<th>Acquisition</th>
<th>Latency</th>
<th>Transmission and Retention</th>
</tr>
</thead>
</table>
| hours-days | days-weeks | weeks-lifetime
| ~8 hours | 2-3 weeks | Inc. 4-8 hrs; Retention - lifetime

### Current AY management

**Carrot**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Planting</td>
<td>Crop growth</td>
<td>Harvest</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**Aster Leafhopper**

- Migratory
- Local
- 1st – 3rd Generation

- Foliar insecticide applications (or row cover!!!!!!)
- Pyganic; Aza-Direct
### Significant Problems in Field Crops

#### Two-spotted spider mites, *Tetranychus urticae*

**Occurrence**
- Usually occur in hot dry conditions
- More severe in dusty, roadside locations
- 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 pyrethrum

#### Spider mite, Management

**Cultural**
- Maintain good plant growth, irrigate
- Avoid dusty roads

**Biological**
- Several effective predators
- Avoid broad-spectrum insecticides

**Chemical**
- Unless necessary, do not use
- "Hormoligosis": boosts egg production
- Insecticidal soap, M-pede

#### 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**
- In-furrow insecticides (commercial producers)
- Foliar pyrethrum (Pyganic)
- Cultural:
  - sanitation – remove overwintering sites
  - destroy crop residue

*Not registered for target squash bug egg mass*
Target Pests: Seed Maggot

Onion Maggot Damage

Seed maggots: 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

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

Wisconsin Damage Calendar

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

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

- None available for organics (options for Entrust in the future...?).

Insecticides Registered on Onion for Onion Maggot in WI: 2012

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Company</th>
<th>Active Ingredient for OM</th>
<th>Chemical Class (IRAC group)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diazinon AG500</td>
<td>Makhshim</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>Lorbain 4E</td>
<td>Dow AgroSciences</td>
<td>Chlorpyrifos</td>
<td>OP (1)</td>
<td>At planting in-furrow, Post-planting banded spray over row</td>
</tr>
<tr>
<td>Scottish Growers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLF 100</td>
<td>Syngenta &amp; Incotec</td>
<td>Spinosad</td>
<td>Spinosyn (5)</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 FS500</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. *IRAC: Insecticide resistance action committee

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
- 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>Survival</td>
<td>68°F 77°F 86°F</td>
</tr>
<tr>
<td>Eggs laid/ Female</td>
<td>210 165 63</td>
</tr>
<tr>
<td>Generation time</td>
<td>48 30 17</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>July 1</td>
<td>1 1 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>165 3,969</td>
</tr>
<tr>
<td>August 5</td>
<td></td>
</tr>
<tr>
<td>August 12</td>
<td></td>
</tr>
<tr>
<td>August 19</td>
<td>210</td>
</tr>
<tr>
<td>August 26</td>
<td>15,752,961</td>
</tr>
<tr>
<td>September 2</td>
<td>27,225</td>
</tr>
</tbody>
</table>

Number generations 1 2 4

Onion thrips: Management

Cultural
- Crop rotation
- Overhead irrigation
- Sanitation (culis & 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)**
  - Macrocyclic lactones (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
  - Aza-Direct
  - Entrust

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

(Acalymma vittatum)

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
Cucumber beetles: Management

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

Blue Hubbard

Black plastic

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)

Insects Impact Cucurbit Production

Pollinators...

...and Devastators

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

Cole Crops - Insect Pest Complex

- Diamond back moth
- Imported cabbage worm
- Cabbage looper
- 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

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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

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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

**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>

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Flea beetles

Cructer flea beetle – *Phyllotreta crucetarae*
Potato flea beetle – *Epilips cucumeris*
Corn flea beetle - *Chaetocnema ectypa*
Eggplant flea beetle – *E. luscula*

Flea beetles are small shiny and black and can cause serious damage to seedlings. They usually feed on the undersides of leaves leaving numerous small round or irregularly shaped holes. Because the beetle is small and active, it usually does not feed much in one spot. It is especially active during hot and sunny days. They can also be a problem in the fall.

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Early Season Pests of Brassicas, Fruiting Vegetables, and Leafy Greens

**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, Chinese giant mustard, glossy-leaf collards) – perimeter trap crops
- Delay planting to allow trap crops to emerge first
- Crop rotation, avoid Brassicas in similar sites year to year
- Sanitation of Brassica weeds

**Biological**
- Few effective controls

**Chemical**
- Repeat applications of natural pyrethrums or spinosad necessary (recolonization)
- Azadirachtin has potential during modest populations
- DO NOT disrupt biological controls for caterpillar pests

Control of Flea Beetles

**Barriers- Row covers**

Garden fleahopper - 2012

- *Halticus bractatus* (Hemiptera: Miridae)
  - Foliar-feeding, polyphagous pest (bean, beet, cabbage, celery, cucumber, eggplant, lettuce, pepper, potato, pumpkin, squash, tomato, and numerous weeds)
  - 2-3 generations / year (WI and IN)
  - Overwinters as eggs (forage crops) and can develop large populations in forages

- Damages are whitish and yellow speckling plus frass (black spots)

- Possible explanations for occurrence:
  - Rarely considered a problem in commercial vegetable production
  - Suppression with insecticides is easily accomplished
  - Reductions in broad-spectrum insecticide use in row crops and adjoining forage legumes may be partially responsible

Brown Marmorated Stink Bug

Know Your Stink Bug’s
Identifying the Brown Marmorated Stink Bug

Look for these unique identifying features...

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

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 build up 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 *Trissolcuis sp*. <5%
  - % parasitism in China 50-80%
- Highly mobile and "nervous" insect

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 Pelletier and Pest Diagnostic Clinic
  - Department of Entomology, Rm. 240
  - 1600 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
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?

SWD Identification - adults

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

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

Vegetable IPM Resources

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

[Link](http://www.entomology.wisc.edu/vegento)