Insect Pest Management
Cucurbit Vegetable Crops

March 10, 2011

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

- Important production state nationally: ranked 2nd in total processing production

- Good crop climate also limits pests

- Production linked historically to canning industry

- Recent increase in fresh market
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 (Reduced-risk & Bio-pesticides).
Insect Management on Vegetables

The problem:
Many Insects on Many Crops

Some perspective on insects:

Why is it difficult to manage insects?

1. Lots of insect species on the planet
   - Over 1 million animal species
   - $\frac{3}{4}$ are arthropods
   - Remember: only a few are actually pests

2. Each species has lots of individuals
   - Short life cycles
   - High numbers of individuals
   - Combination = \textit{HIGH REPRODUCTIVE CAPABILITY}
Factors that regulate insect populations

1. Physical Factors
   – Environment
     Temperature, rainfall
   – Pesticides

2. Biological Factors
   – Influence increases at higher populations
   – Competition
   – Food availability
   – Parasites, predators
   – Disease

Insect management seeks to blend various biological and physical factors together to hold pests at acceptable levels.
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**
Insect Management Trends on Vegetables

Present and Future

Targeted insecticide use

Integration of non-chemical alternatives

Reduced risk, ecologically-based IPM
Cucurbit Insect Control

➢ **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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leafminers</td>
<td>Seed maggots</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flea beetles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flea beetles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrips</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pickleworm</td>
<td>Squash Bug</td>
<td>Cucumber Beetles</td>
<td>Squash Vine Borer</td>
<td>Whiteflies</td>
<td>Aphids</td>
<td></td>
</tr>
</tbody>
</table>
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

### Crop Susceptibility

<table>
<thead>
<tr>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucurbits (squash, cucumber, melon)</td>
<td>Peas</td>
<td>Corn</td>
</tr>
<tr>
<td>Beans (lima, snap)</td>
<td>Beans (soy, kidney)</td>
<td></td>
</tr>
<tr>
<td>Brassica roots (radish)</td>
<td>Brassica (broccoli, cauliflower)</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. 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**
- Commercial seed treatments (Entrust)
Alternative Chemical Control

- Insecticide seed treatments (2011)
  - Cucurbit seed treated with spinosad = Entrust
  - Availability 2012
  - Syngenta Crop Protection – Rogers Seeds

![Image of cucumber, pumpkin, and squash seeds]
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
Striped cucumber beetle

(Acalymma vittatum)
Cucumber Beetles: Damage

- Defoliation
- Feeding scars
- Pollination interference
- 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.
- 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

Managing Cucumber Beetles

Cultural Control

Behavioral 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
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??

Foliar Pyrethrums ($22-28 / A)

Striped cucumber beetle

Planting

Row cover

Cucurbit Crop

Harvest

Cucumber beetles: Management

Cultural

- Later planting
- Eliminate weeds, weedy edges (sanitation)
- Row cover early
- Crop rotation
- Transplants
- Trap crops on plastic mulches

> Kaolin Clay (Surround)
  - Target 1st, 2nd instar (suppression)
  - Multiple applications
  - Good coverage (7-25 lb/A)

> Beauvaria bassiana (Mycotrol O)
  - Target 1st, 2nd instar (suppression)
  - Multiple applications
  - Good coverage (0.25 – 1 qt/A)

> Pyrethrum (Pyganic)
  - Target 1st, 2nd generations
  - 1-2 applications (8-12 oz / A)

Biological

- None effective

Chemical

- Avoid flowering to protect bees (late afternoon / evening sprays)
- Foliar insecticides (pyrethrum, azadirachtin, kaolin clay, Beauvaria bassiana)
Insects Impact Cucurbit Production

Pollinators...

European honey bee

...and Devastators

Striped cucumber beetle
European honey bee

(*Apis mellifera*)
Can we rely on honey bees to pollinate cucurbit crops?
Factors Harming Honey Bee Populations

- Diseases (e.g., American foul brood)
- Parasitic mites (NRC 2006)

Tracheal mite (*Acarapis woodi*)
Varroa mite (*Varroa destructor*)
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
Factors Harming Honey Bee Populations

- Colony Collapse Disorder (CCD)
  - caused by the Israeli Acute Paralysis Virus (IAPV) that weakens bee’s immune system (Stokstad 2007)
  - Fungicide interactions
  - honey bee colonies lose all of their worker bees
  - responsible for a loss of 50-90% of colonies in beekeeping operations across the U.S.
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**
- pyrethrums
- Cultural:
  - sanitation – remove overwintering sites
  - destroy crop residue
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 pyrethroids
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
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
- Direct observation = entrance holes & frass

**Cultural**
- Practice good field sanitation – destroy residue

**Chemical (re-application)**
- Natural pyrethins
- *Bacillus thuringiensis* var. ‘kurstaki’
Cucurbit Virus Complex

**Major Viruses:**

Cucumber mosaic virus (CMV)
Watermelon mosaic virus-2 (WMV-2)
Papaya ringspot virus (PRV) (synonymous WMV-1)
Squash mosaic virus (SqMV)-cucumber beetle / seed
Zucchini Yellow Mosaic Virus (ZYMV)

**Minor Viruses:**

Tobacco ringspot virus (TRV)-nematode
Tomato ringspot (TmRSV)-nematode
Clover yellow vein virus (CIYVV)
Beet curly top virus (BCTV)
Beet pseudo-yellows virus (BpYV)
Cucumber mosaic virus

- Widely distributed
- Non-crop inoculum sources
- Stunting, leaf curl
- Elongate, shoestring leaf
- Color breaking

- Regularly encountered
- Leguminous plant hosts (e.g. clover)
- Mild mosaic
- Rugose leaf, cupping
- Fruit distortion and color breaking

Watermelon mosaic virus - 2
New Pest

Aphis glycines, soybean aphid

Lee 2002
Non-Persistent Virus Transmission

- **Non-circulative** (CMV, WMV-2, PRV, ZYMV)
  
  often referred to as “stylet-borne”

- **Non-propagative**
Non-Persistent Transmission: Movement in Insects

- **Food Ingestion**
  - Pathogen particles attach to maxillary lumen

- **Egestion**
  - Pathogen particles released with saliva
Nonpersistent Transmission

- **Acquisition time** - time required to acquire pathogen
  - Seconds

- **Inoculation time** - time required by infectious insect to inoculate a susceptible host
  - Seconds

- **Latent period** - (minimum time between acquisition of a pathogen and ability to transmit)
  - Zero

- **Retention time** - time after acquisition that a vector remains capable of transmitting the virus
  - Minutes to hours

Chemical controls = no option!!
Landing of Migrating Aphids

- Alighting aphids orient preferentially to plants showing a contrast against a bare soil background
  - concentrates landing
    - around field margins if field has a bare soil border
    - on young plants before canopy closure

- Eliminating contrasting background reduces landing rates
  - border planting; inter-planting
  - reflective mulches
Reflective Mulch for Aphid/Virus Management

**Theory:**
- Repels winged aphids (reflected UV)
- Delays aphid colonization
- Delays virus infection
- Reduces virus symptoms
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

- Severe Agricultural and Nuisance Problems Present
- Nuisance Problems Only
- Detected
Projected Life Cycle of BMSB

1st Gen Adults
Appear in June/July

Overwinter as adults
Emerge early April

Nymphs
5 nymphal instars
May-June

1st Gen eggs
late April thru May

G. Brust
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**
Insecticidal Control

- Contact activity more important than toxicity by ingestion

Exposed to insecticide-treated Petri dishes for 4.5 hrs

Stink bugs transferred to carrot and mortality recorded for 7 days
<table>
<thead>
<tr>
<th>Insecticide</th>
<th>PHI (days) - # Appl.</th>
<th>LI (Lethality Index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endosulfan (Thionex) (voluntary cancellation)</td>
<td>21 d – 3</td>
<td>90.4</td>
</tr>
<tr>
<td>Lannate</td>
<td>15 d – 5</td>
<td>90.1</td>
</tr>
<tr>
<td>Lorsban (in review)</td>
<td>Prebloom only</td>
<td>89.0</td>
</tr>
<tr>
<td>Permethrin</td>
<td>Petal fall only</td>
<td>77.1</td>
</tr>
<tr>
<td>Guthion</td>
<td>21 d – 2</td>
<td>71.3</td>
</tr>
<tr>
<td>Danitol</td>
<td>14 d – 3</td>
<td>66.7</td>
</tr>
<tr>
<td>Carzol</td>
<td>Petal fall only</td>
<td>63.5</td>
</tr>
<tr>
<td>Actara</td>
<td>35 d – 2</td>
<td>56.3</td>
</tr>
<tr>
<td>Clutch/Belay</td>
<td>7 d – 2</td>
<td>55.6</td>
</tr>
<tr>
<td>Baythroid</td>
<td>7 d – 2</td>
<td>54.8</td>
</tr>
<tr>
<td>Warrior</td>
<td>21 d - 3</td>
<td>52.9</td>
</tr>
<tr>
<td>Asana</td>
<td>21 d - 3</td>
<td>43.3</td>
</tr>
</tbody>
</table>

T.C. Leskey, 2010
If you see (suspect) a Brown Marmorated Stink Bug…


- 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)
Websites with information

- Purdue University:  

- Rutgers, The State University of New Jersey:  
  [http://njaes.rutgers.edu/stinkbug/](http://njaes.rutgers.edu/stinkbug/)

- NE IPM Center:  

- University of Florida:  
  [http://creatures.ifas.ufl.edu/veg/bean/brown_marmorated_stink_bug.htm](http://creatures.ifas.ufl.edu/veg/bean/brown_marmorated_stink_bug.htm)

- Massachusetts:  
  [http://www.massnrc.org/pests/pestFAQsheets/brownmarmoratedstinkbug.html](http://www.massnrc.org/pests/pestFAQsheets/brownmarmoratedstinkbug.html)
QUESTIONS?