Season-Long Patterns of Attraction of Brown Marmorated Stink Bug to Pheromone Lures and Light Traps in Orchard Agroecosystems

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Development of Effective Detection and Monitoring Tools

- Tools that provide accurate measurements of presence, abundance, and seasonal activity of BMSB.

- Growers can make informed management decisions.
Key Components: Earlier Studies

- **Visual Stimulus**
  - Large black pyramid

- **Olfactory Stimulus**
  - methyl \((2E,4E,6Z)\)-decatrienoate

- **Capture Mechanism**
  - Tapered pyramid to inverted funnel jar with DDVP toxicant strip

- **Deployment Strategy**
  - Traps placed in peripheral row of orchard
Pheromone of *Plautia stali*

- Methyl (2E, 4E, 6Z)-decatrienionate.
- Cross attractive to brown marmorated stink bug and other pentatomids.
- Reports from Asia and U.S.
Will BMSB Respond to Methyl \((2E, 4E, 6Z)\)-Decatrienoate in the early-season?

- Reports of early-season attraction in Asia.
- Previous trials had relied on low doses (<5 mg).
- Evaluated 66 mg lures.
Despite Reports in the Asian Literature, Our Only Attractant Fails During the Early- and Mid-Season

Methyl (2E,4E,6Z)-decatrieionate (MDT) attractive to adults only during the late-season. Confirmed in MD, WV, NJ, PA, VA and other states in 2011. Not attractive to adults in early- and mid-season.
Almost No Captures in Traps Baited with MDT, Despite Very Large Immigrating Populations

Mean No. Per Trap

Sample Date

Serious Early-Season Invasion Period
Identification of BMSB Aggregation Pheromone
Identification of the BMSB Aggregation Pheromone

9-30 September 2011

Traps baited with #10 captured ~15x more than control and ~3-4x more than other treatments.
Is #10 Attractive in the Early Season?
Pre-Trial (March 20-April 17, 2012)
Early Season Attraction Documented for BMSB
March 20-April 17, 2012

N = 77 BMSB

N = 8 BMSB

Mean No. Adults Per Trap

#10

Control

Treatment

*
Biology, Ecology, and Management of Brown Marmorated Stink Bug in Orchard Crops, Small Fruit, Grapes, Vegetables, and Ornamentals

USDA-NIFA SCRI Project

- USDA-ARS
  - Appalachian Fruit Research Station, Kearneysville, WV
  - Beneficial Insects Introduction Research Unit, Newark, DE
  - Invasive Insect Biocontrol and Behavior Laboratory, Beltsville, MD
  - Horticultural Crops Research Unit, Corvallis, OR
- The Pennsylvania State University
- Washington State University
- North Carolina State University
- Virginia Polytechnic Institute and State University
- Rutgers University
- Northeastern IPM Center
- Oregon State University
- University of Maryland
- University of Delaware
- Cornell University

Photo Courtesy of Chris Bergh

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• University of Maryland
• University of Delaware
• Cornell University
Broad Validation in Multi-State Trial

• Is BMSB attracted to #10 in the early season?

• Is BMSB attracted to #10 season-long?

• How attractive is this stimulus relative to MDT and unbaited traps?

• WV, MD, VA, PA, NJ, NY, DE, NC, OR, WA, and OH
Leveraged and In-Kind Support

USDA-ARS
USDA-APHIS
AgBio
Sterling/Rescue

Total of 350 Traps Deployed Across 12 States
General Protocol

- Black pyramid traps

- Three odor treatments
  - 1) #10 (10 mg)
  - 2) MDT (> 100 mg)
  - 3) unbaited control

- Traps are deployed between wild host habitat and agricultural production area.

- Traps were deployed in mid-April and left in place season-long.
Early Season Summary
Mid-April to Mid-June 2012

- BMSB reliably captured by traps baited with #10.
- These captures represent invading overwintering adults during early season.

Trap Capture Ratios

- #10:Unbaited: 11 : 1
- MDT:Unbaited: 1 : 1
- #10:MDT: 9 : 1
Mid-Season Summary
Mid-June to Mid-August

- Low numbers during much of mid-season.
- Increasing populations beginning in mid-July.

Trap Capture Ratios

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>#10:Unbaited</th>
<th>MDT:Unbaited</th>
<th>#10:MDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-Jun</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Jul</td>
<td></td>
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<td>9-Jul</td>
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<td>16-Jul</td>
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<td></td>
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<tr>
<td>23-Jul</td>
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</tr>
<tr>
<td>30-Jul</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-Aug</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13-Aug</td>
<td>7 : 1</td>
<td>4 : 1</td>
<td>2 : 1</td>
</tr>
</tbody>
</table>

Graph showing mean number per trap from 25-Jun to 13-Aug with increasing trend in early to mid August.
Late-Season Summary
Mid-August to Mid-October

- MDT very attractive and #10 attractive in late season.
- MDT outcompetes #10 in late season at tested release rates.
- Large numbers in the field.

Trap Capture Ratios

- #10:Unbaited 12 : 1
- MDT:Unbaited 90 : 1
- MDT:#10 7 : 1
Seasonal Adult Captures

- Early (mid-April to mid-June): 280 (13:1)
- Middle (mid-June to mid-August): 644 (11:1)
- Late (mid-August to mid-October): 15,332 (22:1)

Sampling Period

Proportional Captures

- #10
- MDT
- Control
Seasonal Nymphal Captures

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>#10</th>
<th>MDT</th>
<th>Control</th>
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</thead>
<tbody>
<tr>
<td>Early (mid-April to mid-June)</td>
<td>2</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Middle (mid-June to mid-August)</td>
<td>5,356</td>
<td>12,856</td>
<td>687</td>
</tr>
<tr>
<td>Late (mid-August to mid-October)</td>
<td>4,342</td>
<td>14,489</td>
<td>663</td>
</tr>
</tbody>
</table>
Dose Response Trial
June 14-July 19, 2012

11:1 Ratio (Baited: Unbaited) for 10 mg lure
~25:1 Ratio (Baited: Unbaited) for 100 mg lure
Lure Affordability: Encouraging Results from Purity Trial
## Commercial Lure Trials

<table>
<thead>
<tr>
<th>Company</th>
<th>Participants</th>
<th>Formulation #1</th>
<th>Formulation #2</th>
<th>#10</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISCA</td>
<td>USDA, WVU, OSU, Cornell, UMD, Rutgers</td>
<td>15 (splat)</td>
<td>53 (septa)</td>
<td>105</td>
<td>26</td>
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<tr>
<td>Scentry</td>
<td>USDA, Rutgers</td>
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<td>N/A</td>
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<tr>
<td>Alpha Scents</td>
<td>USDA, PSU</td>
<td>111 (membrane)</td>
<td>83 (septa)</td>
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<tr>
<td>Hercon</td>
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<td>76</td>
<td>13</td>
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<tr>
<td>Sterling</td>
<td>USDA, PSU, Rutgers</td>
<td>76</td>
<td>N/A</td>
<td>121</td>
<td>43</td>
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<tr>
<td>Trece</td>
<td>USDA, OSU, Cornell</td>
<td>68</td>
<td>N/A</td>
<td>93</td>
<td>43</td>
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</tbody>
</table>
Conclusions

- Aggregation pheromone of BMSB has been identified.
- This stimulus provides reliable, season-long detection of BMSB.
- Likely will need a higher loading of material.
- Crude material can be used to formulate lures, reducing overall costs.
- MDT is very sensitive stimulus in the late-season.
Visual Cues
Identifying Optimal Wavelengths and Intensities of Light
Experimental Light Traps
Night View
A Total of 21 Traps Baited With Light-Based Stimuli Captured 13,457 Adult BMSB in ~6 Weeks During Late Summer

Blue provided greatest level of species-specificity. Fewer non-targets captured.
Traps Provisioned With Blue 25W Compact Fluorescent Bulbs
Attractive and Species-Specific
Season-Long Trial 2012

• Do we capture BMSB reliably with the most attractive stimuli?

• Species-specificity of most attractive visual stimuli?
Mean Weekly Captures

BMSB Captures

Nontarget Captures

Mean No. Adult BMSBs Per Trap

Mean No. Nontargets Per Trap
Season-Long Captures of BMSB

Mean No. Adults Per Trap

Sample Date

12-Jun, 26-Jun, 10-Jul, 24-Jul, 7-Aug, 21-Aug, 4-Sep, 18-Sep

Blue
Black
White
Control
Conclusions

• Traps provisioned with a white light source captured significantly more BMSBs and significantly more non-targets.

• Traps provisioned with blue light sources captured fewer BMSBs, but also fewer nontargets.

• Although captures of BMSB were lower in traps provisioned with black light sources, patterns of capture are significantly correlated among all light-based stimuli.

• Capture patterns essentially identical among white, blue and black light sources.
Next Steps

• Establish physiological and behavioral state of responders to different stimuli.

• Combining attractive visual and olfactory stimuli.
  – Improve monitoring tools.
  – Develop attract and kill strategies.
Acknowledgements

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