USDA APHIS RESEARCH UPDATE

Spotted lanternfly

Otis Laboratory Scientists Working on Spotted Lanternfly

Miriam Cooperband
Chemical ecology & behavior

Phil Lewis
Pesticides

Juli Gould
Biological control

Joe Francese
Trap design

Hannah Nadel
Artificial rearing
USDA APHIS RESEARCH UPDATE

Spotted lanternfly

Cooperband lab update
- Trap and Lure Development
- Host preference & suitability
- Behavioral bioassays
- Volatile profiles & electrophysiology
- Dispersal study
Spotted Lanternfly Kairomones
## Lure Release Rates & Longevity

<table>
<thead>
<tr>
<th>Compound</th>
<th>Maker</th>
<th>Lure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl salicylate</td>
<td>AlphaScents</td>
<td>1. Pipette bulb</td>
</tr>
<tr>
<td>Sino Green</td>
<td></td>
<td>2. Black heart</td>
</tr>
<tr>
<td>Hercon</td>
<td></td>
<td>3. Laminate square</td>
</tr>
<tr>
<td>AlphaScents</td>
<td></td>
<td>4. High release</td>
</tr>
</tbody>
</table>

1. Pipette bulb
2. Black heart
3. Laminate square
4. High release
Spotted Lanternfly Kairomones

3rd Instar SLF / Trap

Lures with Methyl Salicylate

<table>
<thead>
<tr>
<th>Lure Type</th>
<th>Dose (mg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hercon Hi V2 squares (x2)</td>
<td>49</td>
</tr>
<tr>
<td>Sino Green black heart (x2)</td>
<td>34</td>
</tr>
<tr>
<td>AlphaScents pipette bulb</td>
<td>18</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
</tr>
</tbody>
</table>

$R^2 = 0.974$

$P = 0.0129$
Spotted Lanternfly Kairomones

SLF adults per trap after 9 d

<table>
<thead>
<tr>
<th>Release Color</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control</td>
<td>0.0020</td>
</tr>
<tr>
<td>AlphaScents</td>
<td>AlphaScents</td>
<td>0.0018</td>
</tr>
<tr>
<td>Hi-Release (53 mg/d)</td>
<td>Hi-Release (53 mg/d)</td>
<td></td>
</tr>
</tbody>
</table>

Methyl Salicylate Lures
Trap Testing for Spotted Lanternfly

Mean no. SLF/trap

1st instar with lures 4/19/17 to 5/2/17

2nd instar no lures 5/2/17 to 5/16/17

Adult no lures 8/26/16 to 9/10/16

Packing tape
KBIL bands
Web-Cote bands
Trap Testing for Spotted Lanternfly

1st instar SLF caught/tree/day

- **BugBarrier**: Low density site, unbaited bands on pairs of *Ailanthus* trees
- **WebCote**: More SLF, fewer non-targets!
Traps & Lures for Spotted Lanternfly

- Methyl salicylate lures improved trap capture of 3rd instar and adult SLF by roughly 3-fold.
- Webcote sticky bands caught roughly twice as many nymphs and 30x as many adults as KBIL bands.
- BugBarrier caught 3-4 times more 1st instar SLF at a low density site than Webcote, making it a better detection tool at least for 1st instars.
- It was observed that BugBarrier also reduced non-targets, and had a longer field life.
- We continue to test BugBarrier and several additional trap designs in 2018 to develop better trapping options for 4th instars and adults.
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Greg Setliff, Cathryn Pugh, & Michael Toolan
Kutztown University

Leslie Abreu, Stefani Cannon, Kelley Murman, & Matt Wallace
Otis Laboratory / East Stroudsburg University

Jacob Wickham
Chinese Academy of Sciences

Isaiah Canlas
Otis Laboratory / University of Florida
 Proposed Timing of Adult Behavior and Sex Ratio

Flight was observed to correspond with host depletion in 2017

Approximate time of mating

Focused on FEEDING

Sex Ratio (% male)

0% 25% 50% 75% 100%

8/25 to 8/31 9/1 to 9/14 9/15 to 9/28 9/29 to 10/12 10/13 to 10/26 10/27 to 11/9 11/10 to 11/23

Proposed Timing of Adult Behavior and Sex Ratio

Baker/Domingue/Cooperband
Time to treat trap trees?

If treated in mid-June, will trap trees still work now?
On what plants can SLF feed and develop exclusively from 1st instar to adult?

Field sleeves in PA (10 SLF each)

Cages at Otis Lab (5 SLF each)

2017 Cooperband/Murman/Wallace
On what plants can SLF feed and develop exclusively from 1\textsuperscript{st} instar to adult?

Field sleeves set up on \textit{Ailanthus} and Chinaberry by cooperators in China (5 sleeves per tree species with 10 SLF each)

2017 Cooperband/Wickham
### Summary of Host Suitability Results

<table>
<thead>
<tr>
<th>Plant tested</th>
<th>Scientific Name</th>
<th>Feeding? (survived &gt;7d)</th>
<th>Suitable host for development from first instars to adults?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree-of-heaven</td>
<td><em>Ailanthus altissima</em></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Chinaberry</td>
<td><em>Melia azedarach</em></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Hops</td>
<td><em>Humulus lupulus</em></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Black walnut</td>
<td><em>Juglans nigra</em></td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Wild grape</td>
<td><em>Vitis vinifera sylvestris</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oriental bittersweet</td>
<td><em>Celastrus orbiculatus</em></td>
<td>YES</td>
<td>NO?</td>
</tr>
<tr>
<td>Virginia creeper</td>
<td><em>Parthenocissus quinquefolia</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Weeping willow</td>
<td><em>Salix babylonica</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Black birch</td>
<td><em>Betula nigra</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Blueberry</td>
<td><em>Vaccinium cyanococcus</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Horseradish</td>
<td><em>Armoracia rusticana</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Silver maple</td>
<td><em>Acer saccharinum</em></td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Spicebush</td>
<td><em>Lindera benzoin</em></td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Basil</td>
<td><em>Ocimum basilicum</em></td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

2017 Cooperband/Murman/Wickham
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Isaiah Canlas & Katie Cleary
Otis Laboratory / University of Florida Cooperator
Laboratory Behavioral Bioassays

Cooperband lab
Laboratory Behavioral Bioassays

- Leaves
- Plant volatile collections
- Plant essential oils
- Synthetic compounds
- Compound blends
- Insect volatile extracts
Laboratory Behavioral Bioassays

Frequency and Direction of Choice

Comparison vs control

- black cherry vs control
- Ailanthus vs control
- alfalfa vs control
- Chinaberry vs control
- horseradish vs control
- oriental bittersweet vs control
- hops vs control
- wild grape vs control
- Ailanthus vs control
- Chinaberry vs control
- hops vs control
- Basil vs control
- milkweed vs control
- wild grape vs control
- wild grape vs control

Significant differences (Y) are indicated by the bars.
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Nathan Derstine
Otis Laboratory / University of Florida Cooperator

Linnea Meier
Otis Laboratory / University of Florida Cooperator
Gas Chromatograph (GC) coupled with Electroantennographic Detector (EAD)

* Antennally active compounds.
Volatile collections of plant odors

Ailanthus trunk with adult SLF

Black walnut branch
Ailanthus branch volatiles

antennally active compounds
Electrophysiology

<table>
<thead>
<tr>
<th>Volatile Collections</th>
<th>Antennally Active Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ailanthus branch</td>
<td>10</td>
</tr>
<tr>
<td>Ailathus branch + SLF</td>
<td>3</td>
</tr>
<tr>
<td>Ailanthus trunk</td>
<td>3</td>
</tr>
<tr>
<td>Black walnut branch</td>
<td>17</td>
</tr>
<tr>
<td>Hops</td>
<td>10</td>
</tr>
</tbody>
</table>

- Developed a GC-EAD method for *Lycorma delicatula*
- Sampled volatiles from 6 different potential hosts
- Identified 39 unique EAD responses from host plant volatiles
- Identified 19 of those compounds
- Tested/ing novel compounds in behavioral bioassays and field
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Nathan Derstine
Otis Laboratory / University of Florida Cooperator

Kelley Murman, Stefani Cannon, Leslie Abreu, & Matt Wallace
Otis Laboratory / East Stroudsburg University
2017 Methodology

Distance of banded trees to ALL release trees

<table>
<thead>
<tr>
<th>Distance from release trees (m)</th>
<th># of banded trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1-7</td>
<td>4</td>
</tr>
<tr>
<td>7-14</td>
<td>11</td>
</tr>
<tr>
<td>14-21</td>
<td>10</td>
</tr>
<tr>
<td>21-28</td>
<td>13</td>
</tr>
<tr>
<td>&gt;28</td>
<td>58</td>
</tr>
</tbody>
</table>
Capture... mark... release... recapture
Methodology – ... and recapture

24hr count

Interval counts with UV light
<table>
<thead>
<tr>
<th>%Recaptured</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10.3%</td>
<td>9.3%</td>
<td>1.6%</td>
<td>1.6%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

**Recapture Distances**

<table>
<thead>
<tr>
<th>Distance from release tree (m)</th>
<th>0</th>
<th>1-7</th>
<th>7-14</th>
<th>14-21</th>
<th>21-28</th>
<th>&gt;28</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>82.1%</td>
<td>13.7%</td>
<td>3.4%</td>
<td>0.9%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2nd</td>
<td>90.9%</td>
<td>5.7%</td>
<td>2.3%</td>
<td>1.1%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3rd</td>
<td>83.3%</td>
<td>4.2%</td>
<td>12.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>4th</td>
<td>57.1%</td>
<td>7.1%</td>
<td>0.0%</td>
<td>35.7%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Adult</td>
<td>45.5%</td>
<td>9.1%</td>
<td>27.3%</td>
<td>9.1%</td>
<td>9.1%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Summer 2018 Study Underway

- Measure the distance SLF are attracted by the *Ailanthus* trap tree(s) , and where else they end up (non-*Ailanthus* trees)
- % recapture of released SLF
- N=5 transects
Conclusions

- High release methyl salicylate lures improve trap catch by approximately 3x.
- Forty other antennally active plant compounds exist, half of which have been identified.
- Kairomones were identified and certain blends were much more attractive than methyl salicylate in the laboratory.
- Improved traps are being investigated.
- New developmental host records: chinaberry, hops, black walnut.
- SLF prefer to stay on *Ailanthus* if available and do not move much if it’s a healthy tree. However, movement started to increase at 4th instar and adults, coinciding with tree decline.
Chemical/behavioral ecology lab studies underway or planned in 2018:

• Continue semiochemical discovery by conducting volatile collections, analysis by GC-MS, GC-EAD, and Y-tube studies.
• Compare odors of more plants to Ailanthus for preference.
• Compare novel compounds against methyl salicylate and/or each other to determine the most attractive compound.
• Continue to develop and test blends in Y-tube against methyl salicylate.
• Develop lures to test novel attractive compounds in the field.
• GC-EAD of male antennae to female volatiles and vice versa.
• Electroretinograms to assess possible color preferences.
Spotted Lanternfly Kairomones

Field testing for 2018:
• Test AgBio and AlphaScents MeSal lures for longevity in the field.
• Evaluate MeSal lures in low density for detection.
• Test best blend lures against MeSal lures.
• Test new semiochemical(s) against MeSal.
• Test several new traps/designs.
• Trap tree active space test using mark-release-recapture.
• Field host suitability studies on additional species.
• Adult mating/attraction studies and volatile collections.

2018 Cooperband Lab SLF Team:
Satellite lab in PA:
• Kelly Murman
• Stefani Cannon
• Leslie Abreu

Otis Lab:
• Isaiah Canlas
• Nathan Derstine
• Linnea Meier
• Sam Stella
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• Marci Murray
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• Allard Cossé
• Juli Gould
• Phil Lewis
• Scott Myers
• Damon Crook
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