Developing a Behaviorally-Based Attract and Kill System for Spotted Wing Drosophila

Leskey Laboratory
USDA ARS
Appalachian Fruit Research Station
Kearneysville, WV 25430
Optimizing Components of Trap-Based Monitoring and Management Systems

- Visual Stimulus
- Olfactory Stimulus
- Deployment Strategy
- Capture Mechanism
Perimeter-Based Attract and Kill System for Apple Maggot
“Proof of Concept” Attract-and-Kill Study

Will SWD alight on red spheres? What effect does their presence have on infestation?

- Released 25 males and 25 females into field cages.

- Treatments
  - Sphere alone
  - Sphere + olfactory attractant
  - Sphere + raspberry plant
  - Sphere + olfactory attractant + raspberry plant
  - Raspberry plant alone

- Flies foraged freely for 48 h.

- Recorded number of SWD captured (kill) and number of larvae + pupae recovered from fruit (control).
SWD infestation in raspberries reduced by 50% when sphere included in the cage.

SWD alighted on spheres, but captures reduced by 50% in presence of raspberry plant.
Can We Develop an Attract and Kill System for SWD?

- Visual Stimulus
- Olfactory Stimulus
- Deployment Strategy
- Capture Mechanism
Does SWD Respond To Visual Cues?
What Did We Know?

• Visual cues used by drosophilids to discriminate among hosts (Menne and Spatz 1977).

• *Drosophila melanogaster* utilizes visual cues, particularly vertical edges, when responding to odor (Frye et al. 2003).

• Basoalto et al. (2013) reported that flies responded in greatest numbers to red and black stimuli in laboratory studies, but didn’t necessarily translate in the field.
Visual Ecology of SWD

• Identifying Attractive Visual Cues

• Color, Shape and Size

• Laboratory, Semi-field and Field Trials
Visual Stimuli

Color

Shape

Size
• Release 20 colony-reared, mature anesthetized SWD into cage.

• SWD permitted to freely forage for 6h.

• Release 30 colony-reared, mature anesthetized SWD.

• SWD permitted to freely forage for 48h.

• Assess response of wild SWD populations.

• Stimuli in field for 48h.
Conclusions From Visual Ecology Trials

• SWD do respond to visual cues.

• Color appears important as black and red routinely outperformed other colors.

• A spherical shape with a size greater than 2.5 cm appears acceptable.
Could An Olfactory Attractant Improve Efficacy?

Mean No. SWD Captured Per Sphere

<table>
<thead>
<tr>
<th></th>
<th>Baited</th>
<th>Unbaited</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Baited: 35
- Unbaited: 4
Results are mixed, but appears that including a bait with sphere can improve overall attractiveness.
Can We Replace Tangletrap as Killing Agent?

• Evaluate lethality of attracticidal spheres developed for AMF for SWD.

• Cap contains a feeding stimulant (sugar) and toxicant.

• Exploits environmental moisture to continuously renew toxicant on sphere surface.
Laboratory Evaluation of Lethality

- Insecticides: Bifenthrin, Lambda-cyhalothrin, Spinetoram, and Spinosad.

- Rates: 0.0, 0.01, 0.1, 0.5 and 1.0% a.i.

- Evaluated a minimum 20 males and 20 females/insecticide/rate.

- Released at sphere equator and allowed to forage freely for 5 min. Measured foraging time.

- Evaluated toxic effects at 0, 24 and 48 h after exposure
Field Trial of Attracticidal Spheres

Can we reduce SWD infestation in a susceptible crop using attracticidal spheres?
Experimental Set-Up

• Potted raspberries with ripe fruit placed in field.

• Four experimental treatments evaluated for SWD management.
  1) weekly sprays (Brigade, Entrust or Danitol)
  2) 1% Delegate attracticidal spheres (1 per plant)
  3) sprays + spheres
  4) Control

• Monitored SWD populations with traps baited with yeast/sugar.

• Harvested ripe berries and evaluated infestation rates.
Infestation Rates from Attracticidal Sphere Field Trial

<table>
<thead>
<tr>
<th>Treatment Regime</th>
<th>Mean No. SWD Larvae and/or Pupae Per Berry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphere</td>
<td>a</td>
</tr>
<tr>
<td>Spray</td>
<td>a</td>
</tr>
<tr>
<td>Sphere + Spray</td>
<td>a</td>
</tr>
<tr>
<td>Control</td>
<td>b</td>
</tr>
</tbody>
</table>
Can We Find a Better Insecticide Formulation?
Continued Lethality Trials

• Toxicoant Requirements With Current System
  – Dry formulation
  – High % AI
  – Ideally, an organically approved material

• Venom (Dinotefuran) was very promising in laboratory trials.

• 1% Venom used in field trials in 2014.
2014 Field Trial

• Raspberry planting.

• Four experimental treatments evaluated for SWD management.
  1) weekly sprays (Brigade, Delegate or Danitol)
  2) 1% Venom attracticidal spheres (1 per plant)
  3) sprays + spheres
  4) Control

• Monitored SWD populations with traps baited with yeast/sugar.

• Harvested ripe berries and evaluated infestation rates.
What If We Include A Bait?

- Raspberry plots of four NH Growers.
- Two experimental treatments evaluated for SWD management.
  1) Grower Control (Normal Practice)
  2) Grower Control + 1% Venom attracticidal spheres (1 sphere every 3 m) + Trece SWD Bait
- Harvested ripe berries and evaluated infestation rates.
Preliminary Results
Tentative Conclusions

• Baited attracticidal spheres appeared to have a positive impact on SWD infestations in raspberry plantings.

• Lower infestation rates in all samples, except one.

• As populations increase, control breaks down.
Next Steps

- Behavioral trials assessing SWD response to spheres +/- baits in context of host plants.
- SWD behavior in host plants.
- Attracticideal sphere formulation issues.
- Deployment strategy.
Post-Doctoral Position Available

• Leskey laboratory seeking a post-doctoral researcher to aid in trials aimed at understanding the behavioral ecology of SWD and developing an effective behaviorally-based management strategy for this invasive pest. Email Tracy Leskey at tracy.leskey@ars.usda.gov for more information.
Acknowledgments

• Northeastern Regional IPM Award
• North American Raspberry and Blackberry Association
• Driscoll Strawberry Associates, Inc.
• Alan Eaton, UNH