Developing Attract-and-kill Strategies To Manage Spotted Wing Drosophila,

Male

Spotted Wing Drosophila

Female

Peter Jentsch
Extension Associate
Questions and Objectives

• What components offer effective olfactory, visual and sensory perception for attraction?

• Can we construct an long lasting, economically viable Attract and Kill station to reduce SWD populations leading to reduced fruit injury?

• Can Attract and Kill (AtK) Technologies work well alone or do they require the combination of other management strategies to reduce pesticide loading in small fruit production systems?
SWD Spread from 2008 – 2013 in the US

- Italy 2009
- Russia 2009
- Spain 2009
- France 2010

Hawaii 1980
First NY detection 2011 in NY
Mid-September Organic Raspberry
Rensselaer & Suffolk Counties
SWD in New York - 2016

First State Capture
June 21, 2016
Wayne County, NY

Monitored in 25 Counties in NYS
Success of SWD in Small Fruit

Occupies a relatively non-competitive niche

- Able to penetrate and oviposit into un-ripened fruit using a highly scleratinized & serrated ovipositor.
Reproductive Success of SWD in Small Fruit

- Optimal development is at 65-70°F, ~12 day generation time.
- Adult flies live for 3-6 weeks, and females can lay over 300 eggs.
- Limited by high heat in summer and by winter cold. But, SWD populations are found in cold regions of Japan.
- 3-10 generations in NY
### Fruit Affected by SWD

<table>
<thead>
<tr>
<th>Highest risk</th>
<th>Moderate risk</th>
<th>Alternate hosts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strawberries</td>
<td>Peaches</td>
<td>Wild plants with berries, such as...</td>
</tr>
<tr>
<td>Raspberries</td>
<td>Grapes</td>
<td><strong>Tartarian Honeysuckle</strong></td>
</tr>
<tr>
<td>Cherries (Late var,)</td>
<td>Pears</td>
<td>Snowberry</td>
</tr>
<tr>
<td>Nectarines</td>
<td>Apples</td>
<td>Elderberry</td>
</tr>
<tr>
<td>Blueberries</td>
<td>Tomato</td>
<td>Pokeweed</td>
</tr>
<tr>
<td>Blackberries</td>
<td></td>
<td>Dogwood</td>
</tr>
</tbody>
</table>

*Alternate hosts include wild plants with berries, such as Tartarian Honeysuckle, Snowberry, Elderberry, Pokeweed, and Dogwood.*
Honeysuckle is a primary host for SWD; *L. tartarica* fruit favored over raspberry in June-August.
Sampling and Monitoring Protocols

**Monitoring**
Weekly trap captures, 4 traps per site including Tartarian Honeysuckle *L. tartarica*
Extension Outreach: EDDMaps

**Sampling**
Weekly 25 fruit from each of 4 plant clusters (10')
Weigh and assess fruit for SWD eggs (expressed as eggs/gram)
Fruit Monitoring & Injury

- SWD oviposition may precedes adult trap captures in production systems.
- Newer traps have increased sensitivity to adult presence
- Conventional and organic production systems contain raspberry fruit with SWD eggs & larva.
## SWD Control in Mixed Small Fruit; Orange Co. 2012

<table>
<thead>
<tr>
<th>Date</th>
<th>Material</th>
<th>Rate</th>
<th>Commodity</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Malathion 57</td>
<td>2 pts./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>1</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>5</td>
<td>Malathion 57</td>
<td>2 pts./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>12</td>
<td>Delegate 25WDG</td>
<td>3 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>14</td>
<td>Brigade</td>
<td>8 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>19</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>22</td>
<td>Danitol</td>
<td>16 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>27</td>
<td>Mustang Max</td>
<td>4 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>30</td>
<td>Assail 30SG</td>
<td>5 oz./A</td>
<td>Raspberry</td>
</tr>
<tr>
<td>5</td>
<td>Delegate 25WDG</td>
<td>3 oz./A</td>
<td>Raspberry</td>
</tr>
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<td>19</td>
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<td>8 oz./A</td>
<td>Raspberry</td>
</tr>
</tbody>
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6.31” Rainfall; 6 day application interval
Managing Insecticide Resistance: Raspberry

Orange County Fruit Infestation - 2013

Raspberry Management

6.31” Rainfall

Eggs/Larvae per Gram

Raspberry
Blackberry
House Blackberries
Blueberries
Cherry
Strawberry
Tracy Leskey (USDA-ARS)
Developing a Behaviorally Based Attract and Kill System for SWD

- **Color important**: black and red routinely outperformed other colors.
- **A spherical shape**: size greater than 2.5 cm acceptable.
- **Baits** enhance SWD capture
- **SWD infestation in raspberries reduced by 50% when sphere with sugar and bait in caged studies. Sprayed fruit + AtK in combination most effective in managing SWD compared to either alone under high pressure.**

Bait comparisons of SWD in blueberry

- **Suzukii and Trece baits very effective at capturing SWD with Trece and apple cider vinegar capturing higher numbers of non-SWD flies.**

Alan L Knight, Esteban Basoalto, Wee Yee. **Adding Yeasts with Sugar** to Increase the Number of Effective Insecticide Classes to Manage Drosophila suzukii (Matsumura) (Diptera: Drosophilidae) in Cherry Pest Management Science · October 2015

**Alan L Knight, Esteban Basoalto, Wee Yee.** Developing a new bait for spotted-wing drosophila in organic cherry production Acta horticulturae 1001(1001):147-152 · July 2013

**Increased attractiveness of bait using bread yeast**, Saccharomyces cerevisiae
- Exceeds the attractiveness of commercial products GF-120® and Nu-Lure®,
- Addition of the sugar-yeast bait to Entrust increased fly mortality 4-fold in early-season bioassays with green and yellow cherries, reducing eggs laid and larval infestations by 50%
SWD Adult Preference Binary Choice Tests
Mean # AtK Component Attractiveness

25% Red Raspberry Concentrate
75% Apple Cider Vinegar
Brewers yeast: *Saccharomyces cerevisiae*
Methods: Development of Attract and Kill for Management of SWD in Small Fruit

AtK Construction

- 3” substrate woven polypropylene netting as a base
- Super Absorbent Polymer (SAP)
- Gelatin
- Red raspberry concentrate
- Apple cider vinegar
- Brewers yeast
- 1% A.I.
- AtK solution applied at 2 mL/disk
Methods: Development of Attract and Kill for Management of SWD in Small Fruit

<table>
<thead>
<tr>
<th>Insecticide Product</th>
<th>Active Ingredient (IRAC Group)</th>
</tr>
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<tbody>
<tr>
<td>Malathion 5EC</td>
<td>malathion (IRAC 1B)</td>
</tr>
<tr>
<td>Imidan 70W</td>
<td>phosmet IRAC 1B</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>acetamiprid (IRAC 4A)</td>
</tr>
<tr>
<td>Scorpion 35 SL</td>
<td>dinotefuran (IRAC 4A)</td>
</tr>
<tr>
<td>Brigade EC</td>
<td>bifenthrin (IRAC 3A)</td>
</tr>
<tr>
<td>Mutang Max</td>
<td>zeta-cypermethrin (IRAC 3A)</td>
</tr>
<tr>
<td>Pyganic EC 1.4</td>
<td>pyrethrin (IRAC 3A)</td>
</tr>
<tr>
<td>Triple Crown</td>
<td>bifenthrin, imidaclonoprid, zeta-cypermethrin (IRAC 3A, 4A)</td>
</tr>
<tr>
<td>Delegate WG</td>
<td>spinetoram (IRAC 5)</td>
</tr>
<tr>
<td>Entrust SC</td>
<td>spinosad (IRAC 5)</td>
</tr>
<tr>
<td>Exirel</td>
<td>cyazypyr (IRAC 28)</td>
</tr>
<tr>
<td>BotaniGard; Mycotrol</td>
<td><em>Beauveria bassiana</em> strain GHA</td>
</tr>
<tr>
<td>BalEnce</td>
<td><em>Beauveria bassiana</em> Diptera-specific strain (HF23)</td>
</tr>
<tr>
<td>Boric Acid</td>
<td>99% Boric Acid</td>
</tr>
<tr>
<td>Hot Shot Maxattrax Roach Powder</td>
<td>99% Boric Acid formulated</td>
</tr>
</tbody>
</table>
Attract and Kill Station Efficacy
Lab Caged Studies (25 SWD  48h  75F  75%rH  14/10 LD)

- Adult Mortality
- Eggs / Gram Raspberry

- 99% Borax
- Hot Shot Maxatrax (99% Boric Acid)
- Entrust SC
- UTC Disk
- UTC

Cornell University
Hudson Valley Research Laboratory
Attract and Kill Station Recharge Efficacy

SWD Eggs Per Gram of Raspberry & Adult Mortality @ 72h 24h (Wet) vs 7d (Dry) treated disks

1% A.I. Entrust (spinosad-Dow)
Attract and Kill Station Recharge Efficacy

SWD Adult Mortality

% Mortality

Dry
Wet
Control

1% A.I. Entrust (spinosad-Dow)
Attract and Kill Station Recharge Efficacy

Eggs Per Gram in Raspberry Fruit

1% A.I. Entrust (spinosad-Dow)
Observations

• Initial weight loss of $\geq 50\%$ in 30 hours and overall seasonal weight loss of 70%.
• Extended rain events increase fluctuations in AtK disk weight.
Observations

- Extended high relative humidity also increase weight.
- Inversely, low rH reduces weight.
- Morning dew is also absorbed by the disk.
Attraction of Drosophila to AtK from Morning Dew

June 14th – September 19th 8:30 AM,
Experimental Field Design

3 Raspberry Plantings on 3 Farm sites in two NY counties
1 Conventional & 2 Organic Production Systems

AtK placement timed for each row (A,B,C)
A. 1st SWD in NY (14th June)
B. 1st SWD on site (19th June)
C. 1st SWD oviposition of fruit (25th June)

* Row spacing- 11’; plant spacing 3’; 2 of 3 sites used wire trellis used to hang AtK stations
3 Raspberry Plantings on 3 Farm sites in two NY counties
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**Split Block**
(Reps I-III)
Red and Yellow Disk sprayed weekly

(Reps IV-VI)
Red and Yellow Disk sprayed 2x/week
Experimental Field Design

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Split Block
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Red and Yellow Disk sprayed weekly
(Reps IV-VI)
Red and Yellow Disk sprayed 2x/week

Treatments

Red   0 1% Borax treated disks spaced at 1.5’ (120) Disks/ side = 240 disks/ row
Yellow 0 1% Borax treated disks spaced at 3’ (60) Disks/ side = 120 disks/ row
Green 0 Untreated disks spaced at 3’ (60) Disks/ side = 120 disks/ row
AtK Management of SWD in Raspberry Trapanni Orchard, Marlboro, NY - 2016

Eggs / gram

(Sprayed weekly)

Red (18”): 86.1%
Yellow (36”): 91.3%
Green (36”): 47.1%
UTC: b

F-Value: 0.99051
P-Value: 0.4415

(Sprayed 2x / week)
SWD Damage Means in Raspberry Fruit

AtK Management of SWD in Raspberry
WestWind Orchard, Accord, NY - 2016

<table>
<thead>
<tr>
<th>Eggs per gram</th>
<th>Red (18”)</th>
<th>Yellow (36”)</th>
<th>Green (36”)</th>
<th>UTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Sprayed 1x / week)</td>
<td>a</td>
<td>50.6%</td>
<td>a</td>
<td>13.4%</td>
</tr>
<tr>
<td>(Sprayed 2x / week)</td>
<td>a</td>
<td>63.4%</td>
<td>a</td>
<td>33.7%</td>
</tr>
</tbody>
</table>

F-Value: 0.53805, P-Value: 0.7993
SWD Damage Means in Raspberry Fruit

AtK Management of SWD in Raspberry
PFP Organic CSA, Poughkeepsie, NY - 2016

Eggs per gram

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Damage</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red (18&quot;)</td>
<td>70.4%</td>
<td>7.02602</td>
<td>0.0001</td>
</tr>
<tr>
<td>Yellow (36&quot;)</td>
<td>64.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green (36&quot;)</td>
<td>44.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UTC</td>
<td>59.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>65.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Sprayed 1x / week)

(Sprayed 2x / week)
Combined Farm & AtK Application Timing

AtK Management of SWD in Raspberry
Fruit Damage Means, Ulster & Dutchess Co; NY - 2016

*59.9% Reduction of Raspberry Fruit Injury over the UTC
Conclusion

• Attract and kill strategies have been shown to provide reduced levels of infestation from spotted wing drosophila in conventional and organic raspberry production systems.

• Further study of placement density and reapplication intervals of AtK disks for optimumal control is needed prior to recommendations for use.

• Use of AtK + 1% Boric Acid in combination with cultural control, frequent harvest intervals, berry sanitation and harvest low temperature storage strategies may decrease the impact of SWD while reducing the resistance potential in SWD populations from frequent insecticide use.
Partnership Thanks

• New York Farm Viability Grant - OAR 15 013

• Greg Loab, NYSAES, Geneva, NY

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  Hudson Valley Research Laboratory

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Poughkeepsie Farm Project, Poughkeepsie, NY

Trapani Farm & Orchard, Marlboro, NY