Updates on Monitoring and Management of Codling Moth

Cherry Fruit Fly Attractants

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Monitoring Codling Moth in Mating Disrupted (MD) Orchards

Standard 1X pheromone lure (4 wk)
- red septa, Biolure membranes
Long-life lures (8 wk)
- gray septa
10X pheromone lure (2-3 wk)
DA lure (pear ester - food attractant)
DA-Combo lure (pear ester + pheromone)
Trap Thresholds in MD Orchards

Using pear ester to monitor codling moth in sex pheromone treated orchards

Brunner and Gut
10X pheromone traps:
4–10 moths

Knight et al. (OSU fact sheet)
DA traps:
2 moths or 1 female moth

Trece recommendation
DA-Combo traps:
5–10 moths
2006 CM Monitoring Study

- 3 lures in large Delta traps
  - 1X, 10X, DA-Combo
- 9 apple orchards using MD
  - Braeburn, 2 Fuji, 2 Gala, Golden Del., 2 Jonathan, Red Del.
- Payson, Santaquin, & Genola
- 2 replicates per orchard
  - 18 traps with each lure
- Mid May to mid Sept
- # moths caught & fruit injury
  - Per generation
  - 400 fruit per orchard per generation
Trap catch was averaged across 3 orchards for each grower.

- More moths were caught in DA-Combo traps.
- Catch in DA-Combo traps followed generation periods.
Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury

**Grower A**

- **Trap thresholds:**
  - 10X trap: 4 moths
  - DA-Combo: 5 moths

- **Fruit Injury:**
  - Braeburn 3.8%*
  - Fuji 2.5%
  - Jonathan 21.0%
  - Mean 9.1%

*Larval entries on Jul 5 & Aug 23
Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury

**Grower B**

**Trap thresholds:**
- 10X trap: 4 moths
- DA-Combo: 5 moths

**Fruit Injury:**
- Gala: 6.8%*
- Jonathan: 27.3%
- Red Del.: 32.3%
- Mean: 22.1%

*Larval entries on Jul 5 & Aug 23

**Graph Details:**
- Mean # Moths per Trap per Night
- Mean of 3 Orchards
- MD dispensers applied
- Week: May 26 to Sep 17
- 1st gen. - 3rd gen.
Comparing Trap Catch Thresholds to Number of Recommend Sprays and Fruit Injury

Grower C

<table>
<thead>
<tr>
<th>Week</th>
<th>May 26</th>
<th>Jun 30</th>
<th>Aug 11</th>
<th>Sep 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moth Count</td>
<td>1X</td>
<td>10X</td>
<td>DA-Combo</td>
<td>All Traps Mean of 3 Orchards</td>
</tr>
<tr>
<td>1st gen.</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>2nd gen.</td>
<td>0.8</td>
<td>0.6</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>3rd gen.</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

MD dispensers applied

Trap thresholds:
- 10X trap: 4 moths
- DA-Combo: 5 moths

Fruit Injury:
- Fuji 1.5%
- Gala 1.3%
- Golden Del. 4.5%
- Mean 2.4%

*Larval entries on Jul 5 & Aug 23
Regression of % fruit injury on cumulative moth catch in DA-Combo traps for 2\textsuperscript{nd} generation

\begin{equation}
\text{Gen2 injury} = 0.7199 + 0.0972 \text{ Gen2DA}
\end{equation}

\begin{align*}
\text{Rsq} &= 0.5259 \\
\text{Adj Rsq} &= 0.4963 \\
\text{RMSE} &= 5.5365
\end{align*}

Utah Co. CM Monitoring in MD Orchards, 2006

Regression of 2nd Gen CM Injury on DA Trap Catch

Approximately 0.1\% larval entries for every moth caught
5 moths $\rightarrow$ 0.5\% injury, 10 moths $\rightarrow$ 1.0\% injury
### Relation of 1\textsuperscript{st} to 2\textsuperscript{nd} Generation Codling Moth Fruit Injury

<table>
<thead>
<tr>
<th>Orchard (Apple Variety)</th>
<th>% fruit with injury</th>
<th>1\textsuperscript{st} generation\textsuperscript{*}</th>
<th>2\textsuperscript{nd} generation\textsuperscript{^}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stings</td>
<td>Entries</td>
<td>Stings</td>
</tr>
<tr>
<td>Braeburn</td>
<td>7.0</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Fuji</td>
<td>7.3</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Fuji</td>
<td>1.8</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Gala</td>
<td>0</td>
<td>0</td>
<td>0.8</td>
</tr>
<tr>
<td>Gala</td>
<td>2.3</td>
<td>2.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Golden Del.</td>
<td>1.5</td>
<td>1.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Jonathan</td>
<td>7.5</td>
<td>8.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Jonathan</td>
<td>2.5</td>
<td>5.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Red Del.</td>
<td>3.0</td>
<td>12.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

\textsuperscript{*}July 5 \quad \textsuperscript{^}August 23
2006 was a tough year for codling moth injury

- High populations
- Even with MD, supplemental insecticide sprays were needed
- Resistance & cross-resistance to insecticides
- Hot weather, 3 generations
- Insecticide timing issues
- Full monitoring program!
- No room for error
Updated the Codling Moth Fact Sheet
http://utahpests.usu.edu/ipm

Includes:
- Monitoring in MD orchards
- Lure types
- Timing insecticides that target multiple life stages
- Revised DD and “management events” table
- Insecticide options
- Mating disruption
Major events in a codling moth management program, based on accumulated degree-days (DD)

<table>
<thead>
<tr>
<th>Degree Days</th>
<th>% Adults Emerged</th>
<th>% Egg Hatch</th>
<th>Management Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>100+</td>
<td>0</td>
<td>0</td>
<td>• Place traps in orchards.</td>
</tr>
<tr>
<td>150–200</td>
<td>1st moths expected</td>
<td>0</td>
<td>• Check traps every 1-2 days until 1st moths are determined.</td>
</tr>
<tr>
<td>50–75</td>
<td>5–9</td>
<td>0</td>
<td>• First eggs are laid.</td>
</tr>
<tr>
<td>100–200</td>
<td>15–40</td>
<td>0</td>
<td>• Apply insecticides that need to be present before egg-laying.</td>
</tr>
<tr>
<td>220–230</td>
<td>45–50</td>
<td>1–3</td>
<td>• Early egg-laying period.</td>
</tr>
<tr>
<td>920</td>
<td>100</td>
<td>99</td>
<td>• End of egg hatch for 1st generation.</td>
</tr>
</tbody>
</table>

Second Generation

<table>
<thead>
<tr>
<th>Degree Days</th>
<th>% Adults Emerged</th>
<th>% Egg Hatch</th>
<th>Management Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000–1030</td>
<td>5–8</td>
<td>0</td>
<td>• First eggs of 2nd generation are laid.</td>
</tr>
<tr>
<td>1100</td>
<td>13</td>
<td>1</td>
<td>• Apply insecticides to target early egg-laying.</td>
</tr>
<tr>
<td>1300–1700</td>
<td>46–93</td>
<td>11–71</td>
<td>• Critical period for control, high rate of egg hatch.</td>
</tr>
<tr>
<td>2100</td>
<td>100</td>
<td>99</td>
<td>• End of egg hatch for 2nd generation.</td>
</tr>
</tbody>
</table>

Third Generation

<table>
<thead>
<tr>
<th>Degree Days</th>
<th>% Adults Emerged</th>
<th>% Egg Hatch</th>
<th>Management Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2100</td>
<td>1</td>
<td>1.5</td>
<td>• Beginning of egg hatch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Keep fruit protected throughout each generation (Table 1).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Critical period for control, high rate of egg hatch.</td>
</tr>
</tbody>
</table>

Recommended timing for insecticides based on their mode of action

- Reapply insecticides based on the residual period (i.e., protection interval) of the product used. Keep fruit protected throughout each generation (Table 1).
- As harvest date approaches, consider the pre-harvest interval (required time interval between insecticide application and harvested) in planning late season treatments.
## 2006 Reduced Risk Insecticide Trial

**Kaysville Research Orchard**

### Table 1. Insecticide treatment applications and timings.

<table>
<thead>
<tr>
<th>Trt</th>
<th>1st generation CM</th>
<th>2nd generation CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rimon 50-75 DD May 15</td>
<td>Rimon 1000 DD Jul 6</td>
</tr>
<tr>
<td></td>
<td>Rimon 14 d later May 30</td>
<td>Rimon 14 d later Jul 22</td>
</tr>
<tr>
<td></td>
<td>Assail 14 d later Jun 12</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rimon + Assail 250 DD May 24</td>
<td>Calypso 1380 DD Jul 12</td>
</tr>
<tr>
<td></td>
<td>Rimon 14 d later Jun 7</td>
<td>Calypso 7 d later Jun 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Esteem 100 DD May 18</td>
<td>Esteem 1050 DD Jul 6</td>
</tr>
<tr>
<td></td>
<td>Assail 350 DD May 30</td>
<td>Assail 1380 DD Jul 22</td>
</tr>
<tr>
<td></td>
<td>Intrepid 14 d later Jun 12</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Oil 150-200 DD May 19</td>
<td>Oil 1100 DD Jul 10</td>
</tr>
<tr>
<td></td>
<td>Intrepid 350 DD May 30</td>
<td>Intrepid 1380 DD Jul 22</td>
</tr>
<tr>
<td></td>
<td>Assail 14 d later Jun 12</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Guthion 250 DD May 24</td>
<td>Calypso 1200 DD Jul 12</td>
</tr>
<tr>
<td></td>
<td>Assail 14 d later Jun 7</td>
<td>Calypso 7 d later Jul 28</td>
</tr>
<tr>
<td></td>
<td>Calypso 7 d later Jun 14</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Mean apple fruit injury

<table>
<thead>
<tr>
<th>Trt #</th>
<th>Insecticides*</th>
<th>% fruit with injury (Jun 28)</th>
<th>% fruit with injury (Aug 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Stings</td>
<td>Entries</td>
</tr>
<tr>
<td>1</td>
<td>Ri-As-Ri</td>
<td>1.8 c</td>
<td>3.0 ab</td>
</tr>
<tr>
<td>2</td>
<td>Ri+As-Ri-Ca</td>
<td>2.0 bc</td>
<td>2.5 abc</td>
</tr>
<tr>
<td>3</td>
<td>Es-As-In</td>
<td>2.3 c</td>
<td>1.8 bc</td>
</tr>
<tr>
<td>4</td>
<td>Oi-In-As/Ca</td>
<td>5.0 ab</td>
<td>2.8 abc</td>
</tr>
<tr>
<td>5</td>
<td>Gu-As/Ca-Ca</td>
<td>2.3 c</td>
<td>1.3 c</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6.0 a</td>
<td>4.5 a</td>
</tr>
<tr>
<td></td>
<td>P&gt;F</td>
<td>0.04</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon
## Non-target effects on mites

<table>
<thead>
<tr>
<th>Trt #</th>
<th>Insecticides*</th>
<th>Mean # mites per 20 leaves</th>
<th>Phyto Mites^</th>
<th>Phyto Mite Eggs</th>
<th>Pred Mite Pred Mites~</th>
<th>Pred Mite Eggs</th>
<th>Thrips</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ri-As-Ri</td>
<td></td>
<td>33.8</td>
<td>8.8</td>
<td>67.8 bc</td>
<td>11.8</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td>Ri+As-Ri-Ca</td>
<td></td>
<td>4.3</td>
<td>0.3</td>
<td>36.5 c</td>
<td>1.8</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>Es-As-In</td>
<td></td>
<td>0.3</td>
<td>0.0</td>
<td>153.3 ab</td>
<td>9.8</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>Oi-In-As/Ca</td>
<td></td>
<td>0.0</td>
<td>1.0</td>
<td>51.0 bc</td>
<td>1.7</td>
<td>0.0</td>
</tr>
<tr>
<td>5</td>
<td>Gu-As/Ca-Ca</td>
<td></td>
<td>1.5</td>
<td>5.5</td>
<td>331.8 a</td>
<td>31.3</td>
<td>0.3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>1.0</td>
<td>2.5</td>
<td>162.3 ab</td>
<td>14.5</td>
<td>0.0</td>
</tr>
<tr>
<td>P&gt;F</td>
<td>0.13</td>
<td>0.76</td>
<td>0.01</td>
<td>0.11</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon

^Phyto Mites = phytophagous mites (two spotted spider mites, brown mites, and rust mites)

~Pred Mites = predaceous mites (Typhlodromus and Zetzellia)
New CM Products

- Insecticides (broad spectrum)
  - Battalion (deltamethrin) - 5th gen. synthetic pyrethroid, less mite flare, Arysta LifeScience Corp.
  - Altocor (rynaxypyr) - new class, “anthranilic diamide”, interferes with calcium gates in muscles, affects movement, DuPont Crop Protection
  - Delegate (spinetoram) - new spinosyn insecticide, Dow AgroSciences
  - Belt and Synapse (flubendiamide) - new class, “phthalic acid diamides”, disruption of cellular calcium balance, Bayer CropScience
New CM Products

- **Pheromone MD products**
  - CideTrak DA-Combo dispenser - pear ester + pheromone in dispenser, Trece
  - CideTrak DA MEC - micro-encapsulated, sprayable pear ester MD product, Trece
  - SPLAT - flowable pheromone dispenser, MD and attract-&-kill if insecticide added, ISCA Technologies
  - Pheromone flakes & fibers - applied in sticky glue, not commercially available
Update on Guthion Registration

- Apple, Pear, Sweet & Tart Cherry
  - Registration will end in 2012
  - Phase-down of allowed pounds per acre for the season
  - 60 ft buffer from treated orchards to bodies of water
  - 60 ft buffer from orchards to human occupied buildings
  - Lengthy PHI for U-pick orchards
Cherry Fruit Fly Attractants

- **GF-120 (bait + 0.2% a.i. spinosad)**
  - Bait is not that attractive
  - Foraging adults encounter droplets and eat them
  - Spinosad is highly toxic upon ingestion

- Interest in developing a more attractive bait

- **Ammonium materials**
  - Ammonium carbonate
  - Ammonium acetate
2006 Trial at Kaysville

- **GF-120 (1:4, 100 fl oz per acre)**
  - Applied 8X

- **GF-120 + 10% Amm. Carbonate (AC)**
  - Applied 8X

- **GF-120 + 10% Amm. Acetate (AA)**
  - Applied 8X

- **Success (6 oz per acre)**
  - Applied 6X

- **Provado 1.6F (8 oz per acre)**
  - Applied 3X

- **Untreated Control**

Photo courtesy of Tim Smith, WSU Ext.
Figure 3. Fruit infestation at harvest (Jul 13) presented by age of larvae and exit holes per 100 fruit. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=GF-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.

Values above bars are total numbers of larvae and exit holes.
Means followed by different letters are significantly different (LSD test; \( p \geq 0.05 \)).
Figure 2. Mean cumulative number of adults per trap (Jun 1 – Aug 17) as influenced by insecticide treatments. GF=GF-120, GFAC=GF-120+10% ammonium carbonate, GFAA=GF-120+10% ammonium acetate, SU=Success, PR=Provado, and UC=untreated control.

Means followed by the same letter are not significantly different (LSD test, \( p > 0.05 \))
Acknowledgements

• Research assistance:
  - Thor Lindstrom, Research Associate
  - Helen Darrow, Lab Manager
  - Students: Douglas Anderson, Britney Hunter, Camille Rowley, Adam Thompson

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  - Utah State Horticultural Association
  - Chemtura Chemical
  - USDA CSREES IPM RAMP Program