Managing secondary pests post-OP insecticides

Ric Bessin
Extension Entomologist
Kentucky Agriculture

Uniqueness of KY Agriculture:

• 5th largest number of farms in US, 86,000
• 39th in farm size, 163 acres (US Census 2012)
• 92,000 miles of rivers and streams, second only to Alaska
• Agriculture in KY has a significant impact on water quality in the state (Kentucky Division of Water 2006, 2010)
• 120 Counties (3rd), each with CES office
• Diverse Agriculture
Marketing Fruit

• Mostly retail sales
• Producers must develop their own markets
• On farm-markets can be lucrative...
  • Location, location, location
Issues with or Small Industry

- May not have legal access to all IPM tools
- Registration of new technologies are often limited to high production states
  - States require annual pesticide registration
  - KY: $250/year/product
  - Mating disruption
  - Biopesticides
General Orchard Pest Management in KY

- Weather dependent
  - Very wet, 5 to 7 day intervals between sprays
  - Dry, 10 to 14 day intervals between sprays
- Majority are *alternate middle row* spraying
  - Not as long between sprays, counting on blow through between rows
  - Frequency?
- Every middle spraying
  - Less frequent
Persistent Problems:
Alkaline Water and Hydrolysis of Pesticides

• Would like spray pH to be 6 as some pesticides are very sensitive to pH
  • Captan, Imidan (high pH)

• Some breakdown over time in water
  • Entrust, SpinTor

• Testing of water at commercial orchards
  • pH 7.2 to 9.3
Alternative to OPs: 4 case studies (2010 and 2011)

- 4 demonstration orchards across the state compared a non-OP program to programs with Ops
  - Half orchard managed by grower, half by UK

- Assail, Altcor, Avaunt, Belt, Calypso, Danitol, Delegate, Intrepid, and Voliam Flexi substituted for Guthion/Imidan

- Evaluate quality and economics at end of season
Codling Moth

- Key pest
- 3 generations
“Planned” Non-OP Programs

- Orchard A and C
  - Avaunt @ petal fall
  - *Calypso* for 1\(^{\text{st}}\) CM gen
  - Altacor for 2\(^{\text{nd}}\) CM gen
  - Delegate for 3\(^{\text{rd}}\) CM gen

- Orchard B and D
  - Avaunt @ petalfall
  - Voliam Flexi for 1\(^{\text{st}}\) CM gen
  - *Belt* for 2\(^{\text{nd}}\) CM gen
  - Delegate for 3\(^{\text{rd}}\) CM gen
### Arthropod Management Tests (Michigan)

<table>
<thead>
<tr>
<th>Treatment/formulation</th>
<th>Rateamt/acre or vol/vol</th>
<th>Applicationtiming</th>
<th>CM/OFM Percentage of Stings</th>
<th>CM/OFM Percentage of Entries</th>
<th>CM/OFM Percentage of CM Larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>–</td>
<td>–</td>
<td>54.0 a</td>
<td>43.5 a</td>
<td>8.0 a</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>6 oz</td>
<td>ABC</td>
<td>19.5 b</td>
<td>0.0 b</td>
<td>0.0 b</td>
</tr>
<tr>
<td>Imidan 70WP</td>
<td>3 lb</td>
<td>DE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tri-Fol L</td>
<td>0.5 pt/100 gal</td>
<td>DE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altacor 35WG</td>
<td>4 oz</td>
<td>FGH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>6 oz</td>
<td>AFGH</td>
<td>14.5 b</td>
<td>0.0 b</td>
<td>0.0 b</td>
</tr>
<tr>
<td>Altacor 35WG</td>
<td>4 oz</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imidan 70WP</td>
<td>3 lb</td>
<td>DE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tri-Fol L</td>
<td>0.5 pt/100 gal</td>
<td>DE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrepid 2F</td>
<td>16 fl oz</td>
<td>ABCDEFGH</td>
<td>30.0 ab</td>
<td>1.0 b</td>
<td>0.0 b</td>
</tr>
</tbody>
</table>

Means followed by same letter do not significantly differ ($P = 0.05$, Tukey’s HSD). ANOVA performed on arcsine square-root transformed data; data presented are actual counts. *A = 30 May (petal fall), B = 12 June (CM bio + 250dd 50), C = 26 June (B + 14 d), D = 10 July (C + 14 d), E = 24 July (D + 14 d), F = 7 August (CM bio + 250dd 50), G = 21 August (F + 14 d), H = 4 September (G + 14 d).
- Guthion/Imidan
- Danitol
- Delegate
- Warrior
- Altacor
- Assail
- Calypso
- Belay
- Proclaim
- Intrepid
- Esteem
- Rimon

- 250 DD
- 200 to 250 DD
- 150 to 200 DD
- 100 DD
- 50 to 150 DD
What Matters?

Trapping indicates when (if) to spray

Timing to get most from your spray
2010 and 2011

- Two very WET years
- Spray intervals shortened due to rainfall events, as much as 8 to 10 inches in one storm
- Very high CM numbers at the start in two orchards with constant moth activity in 2010
Weekly pheromone trap captures of CM in OP and non-OP blocks during 2010 in Orchard A.
Weekly pheromone trap captures of CM in OP and non-OP blocks during 2011 in Orchard A.
Weekly pheromone trap captures of CM in OP and non-OP blocks during 2010 in Orchard D.
Weekly pheromone trap captures of CM in OP and non-OP blocks during 2011 in Orchard D.
Managing secondary pests?
Recognizing Pests

ID-219 available on line
European Red Mite & Two-spotted Spider Mite

Predation very important, sprays that remove predators favor mite outbreaks (preventing problems)

<table>
<thead>
<tr>
<th>Slightly Toxic</th>
<th>Moderately Toxic</th>
<th>Highly Toxic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidan</td>
<td>Acramite</td>
<td>Asana</td>
</tr>
<tr>
<td>Altacor</td>
<td>Apollo</td>
<td>Baythroid</td>
</tr>
<tr>
<td>Assail</td>
<td>Kanemite</td>
<td>Danitol</td>
</tr>
<tr>
<td>Centaur</td>
<td>Savey</td>
<td>Lannate</td>
</tr>
<tr>
<td>Cyd-X (NT)</td>
<td>Vendex</td>
<td>Permethrin</td>
</tr>
<tr>
<td>Diazinon</td>
<td></td>
<td>Proaxis</td>
</tr>
<tr>
<td>Entrust</td>
<td></td>
<td>Sevin</td>
</tr>
<tr>
<td>Esteem</td>
<td></td>
<td>Vydate</td>
</tr>
<tr>
<td>Exirel</td>
<td></td>
<td>Warrior</td>
</tr>
<tr>
<td>Intrepid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rimon</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Actara</td>
<td>Asana</td>
</tr>
<tr>
<td></td>
<td>Admire</td>
<td>Baythroid</td>
</tr>
<tr>
<td></td>
<td>Agri-Mek</td>
<td>Danitol</td>
</tr>
<tr>
<td></td>
<td>Avaunt</td>
<td>Lannate</td>
</tr>
<tr>
<td></td>
<td>Belay</td>
<td>Permethrin</td>
</tr>
<tr>
<td></td>
<td>Delegate</td>
<td>Proaxis</td>
</tr>
<tr>
<td></td>
<td>Lorsban</td>
<td>Sevin</td>
</tr>
<tr>
<td></td>
<td>Supracide</td>
<td>Vydate</td>
</tr>
<tr>
<td></td>
<td>Surround</td>
<td>Warrior</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agri-Mek</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Envidor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Portal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zeal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dicofol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nexter</td>
</tr>
</tbody>
</table>
General Mite Manage Strategy

1. Delayed Dormant Oil @ about 2%
   Green tip to ½ inch green

2. Minimize sprays highly toxic to mite predators

3. Many growers using low rate (0.5%) of oil routinely
   Avoiding Captan, Sevin and other sulfur containing sprays

4. Monitor of mite activity/damage

5. Use miticide only when/if needed
Woolly Apple Aphid

Infrequent outbreaks, but can be serious

Resident underground populations

Causes galls of roots and stems

Outbreaks often follow disruptive sprays
  - often follows periodical cicada
Woolly Apple Aphid

Want to eliminate above ground populations
- below ground damaging

Easy to spot, but check if active
- looks at bark injures
- looks around crown of trees

Infest trees may have yellowed leaves

Rootstock resistance: M. 111 or Malling Merton series

No control for below ground aphids
Woolly Apple Aphid

Recommended insecticides (MX398)

- Diazinon
- Admire
- Movento
- Closer
- Beleaf

Other insecticides (P)

- Imidan
- Sivanto
- Asana
- Danitol
- Warrior
- Sevin
- Lannate
- Vydate
## Woolly Apple Aphid Efficacy Trial, 2016

J. Wise, A. VanWoerkom, & L. Gut

### Treatment/formulation

<table>
<thead>
<tr>
<th>Treatment/formulation</th>
<th>Rate product/acre</th>
<th>Appl. timing</th>
<th>Live WAA colonies/2 min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>21 Sep</td>
</tr>
<tr>
<td>Untreated check</td>
<td></td>
<td></td>
<td>6.8a</td>
</tr>
<tr>
<td>Movento 240SC+</td>
<td>9 fl oz</td>
<td>A</td>
<td>0.8b</td>
</tr>
<tr>
<td>R-11 90EC</td>
<td>0.25% v:v</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Sivanto Prime 1.67 SL+</td>
<td>14 fl oz</td>
<td>B</td>
<td>1.3b</td>
</tr>
<tr>
<td>R-11 90EC</td>
<td>0.125% v:v</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Closer SC</td>
<td>5.75 fl oz</td>
<td>C</td>
<td>1.3b</td>
</tr>
</tbody>
</table>

### Arthropod Management Tests, Volume 42, Issue 1, 1 January 2017

20-yr-old ‘Golden Delicious’

- 100 gpa
- A – June 24
- B – Aug 17
- C – Aug 31
Control of Woolly Apple Aphid, 2008
E. Beers & R. Talley

30-yr-old block
‘Oregon Spur’ & ‘Red Delicious’

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/acre</th>
<th>5-Aug $^3$</th>
<th>12-Aug $^2$</th>
<th>18-Aug</th>
<th>27-Aug $^2$</th>
<th>3-Sep $^2$</th>
<th>11-Sep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movento 240SC$^2$</td>
<td>9 fl oz</td>
<td>75.75ab</td>
<td>81.00a</td>
<td>56.75b</td>
<td>50.25cd</td>
<td>63.50bc</td>
<td>90.25b</td>
</tr>
<tr>
<td>Saf-T-Side Oil</td>
<td>1%</td>
<td>44.00abc</td>
<td>42.00a</td>
<td>58.25b</td>
<td>66.75bc</td>
<td>87.75abc</td>
<td>111.75b</td>
</tr>
<tr>
<td>Cyazypyr 100D$^2$</td>
<td>20.6 fl oz</td>
<td>41.00abc</td>
<td>47.25a</td>
<td>69.75b</td>
<td>90.00ab</td>
<td>93.50ab</td>
<td>150.50b</td>
</tr>
<tr>
<td>Diazinon 50W</td>
<td>4 lb</td>
<td>18.75d</td>
<td>6.50b</td>
<td>10.00c</td>
<td>7.25e</td>
<td>22.75d</td>
<td>52.00c</td>
</tr>
<tr>
<td>Diazinon 50W</td>
<td>2 lb</td>
<td>21.25cd</td>
<td>8.75b</td>
<td>15.25c</td>
<td>26.50d</td>
<td>48.50c</td>
<td>95.25b</td>
</tr>
<tr>
<td>Check</td>
<td>---</td>
<td>78.25a</td>
<td>74.25a</td>
<td>106.25a</td>
<td>123.25a</td>
<td>143.75a</td>
<td>248.25a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/acre</th>
<th>17-Sep $^2$</th>
<th>25-Sep</th>
<th>1-Oct</th>
<th>15-Oct</th>
<th>29-Oct</th>
<th>Seasonal sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movento 240SC$^2$</td>
<td>9 fl oz</td>
<td>170.25b</td>
<td>173.25b</td>
<td>199.50b</td>
<td>59.25c</td>
<td>37.25d</td>
<td>1,057c</td>
</tr>
<tr>
<td>Saf-T-Side Oil</td>
<td>1%</td>
<td>186.75b</td>
<td>136.50b</td>
<td>155.25b</td>
<td>66.50c</td>
<td>61.75cd</td>
<td>1,017c</td>
</tr>
<tr>
<td>Cyazypyr 100D$^2$</td>
<td>20.6 fl oz</td>
<td>185.00b</td>
<td>283.00a</td>
<td>297.25a</td>
<td>126.50ab</td>
<td>98.50b</td>
<td>1,482b</td>
</tr>
<tr>
<td>Diazinon 50W</td>
<td>4 lb</td>
<td>110.75b</td>
<td>148.00b</td>
<td>176.25b</td>
<td>65.25c</td>
<td>68.00cd</td>
<td>686d</td>
</tr>
<tr>
<td>Diazinon 50W</td>
<td>2 lb</td>
<td>146.50b</td>
<td>144.50b</td>
<td>145.25b</td>
<td>59.00c</td>
<td>55.50cd</td>
<td>766cd</td>
</tr>
<tr>
<td>Check</td>
<td>---</td>
<td>370.00a</td>
<td>268.50a</td>
<td>291.00a</td>
<td>153.25a</td>
<td>129.50a</td>
<td>1,986a</td>
</tr>
</tbody>
</table>

Means within columns not followed by the same letter are significantly different, Waller-Duncan k-ratio t-test, k-ratio=100.
Treatments applied airblast 100 gpa on 1 August. Treatment 2 (Saf-T-Side) had a second application on 15 August.
$^3$Data transformed log(x+0.5).
$^2$Treatment included an adjuvant, Saf-T-Side oil, 0.25% v/v.
$^2$Treatment included an adjuvant, Saf-T-Side oil, 0.50% v/v.

Arthropod Management Tests, Volume 34, Issue 1, 1 January 2009
San Jose Scale

Resident in most orchards at low levels

Often noticed while pruning, on new wood
- also at harvest on green fruit

Look for red tissue under bark

Saliva is toxic to hosts
San Jose Scale Strategies

Sticky tape and pheromone traps work
- monitor of crawlers and adults
- degree day model available

Dormant oil to smother nymphs

Most growers now use Esteem at ½” green
- also helps with rosy apple aphid
- 2nd cover alternative timing

Diazinon, Admire, Assail, Centaur, Movento, and Sivanto are also recommended
Brown Marmorated Stink Bug

- 2 wide white bands on antennae
- Smooth ‘shoulders’
- White triangles
Very wide host range
Brown Marmorated Stink Bug Timeline
66/120 counties

- 2010/11 (6 counties)
- 2011/12 (2 counties)
- 2012/13 (19 counties)
- 2013/14 (29 counties)
- 2014/2015 (2 counties)
- 2016/2017 (2 counties)
- Suspected

Map showing the spread of the Brown Marmorated Stink Bug across various counties in the US, notably in Tennessee (Knoxville, Nashville) and Ohio (Cincinnati, Jeffersonville).
Brown Marmorated Stink Bug
Ag Problem Areas

Basically – Pest is widespread and is increasing slowly
BMSB Threat To Apples

High

Unmanaged Threat

Maturing Fruit Becomes Increasingly Attractive To BMSB. Fewer other hosts available.

Moderate

Increasing Populations of BMSB from other hosts (Overlap of Multiple Generations)

Low

Feeding on Fruit Results in Economic Injury

Feeding on Fruit Results in Nominal Injury, but Reproduction Can Occur if Invading Populations Not Managed

J  F  M  A  M  J  J  A  S  O  N  D
Early Season Superficial Injury
Early season feeding results in minimal injury with discolored dot and feeding's head beneath.

Mid-Season Economic Injury
Mid-season feeding results in possible discolored depressions and flesh surrounding feeding's head appearing corky.

Mid-Late Season Economic Injury
Mid-late season feeding results in discolored depressions with larger, corky areas in flesh.
# Insecticides for the control of BMSB

Based on direct contact bioassays (G. Krawczyk, PSU FREC 2011)

<table>
<thead>
<tr>
<th>Product</th>
<th>Active ingredient</th>
<th>Rate tested/ac</th>
<th>Mortality*/lethality index**</th>
<th>PHI/REI</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belay</td>
<td>clothianidin</td>
<td>6.0 oz</td>
<td><strong>100% / 56</strong></td>
<td>21d / 12h</td>
<td>Peach, pome fruit; 2 appl.</td>
</tr>
<tr>
<td>Lannate SP</td>
<td>methomyl</td>
<td>16.0 oz</td>
<td><strong>98% / 90</strong></td>
<td>14d / 72h</td>
<td>5 applications per season, no nectarine label</td>
</tr>
<tr>
<td>Actara</td>
<td>thiametoxam</td>
<td>5.0 oz</td>
<td><strong>98% / 56</strong></td>
<td>35d PF; 14d SF / 12h</td>
<td>PF less than 0.258 lb AI per season; SF less than 0.172 lb (2 appl)</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>acetamiprid</td>
<td>8.0 oz</td>
<td><strong>95% / 19</strong></td>
<td>7d / 12h</td>
<td>4 appl. per season</td>
</tr>
<tr>
<td>Admire Pro</td>
<td>imidacloprid</td>
<td>7.0 oz</td>
<td><strong>88% / 40</strong></td>
<td>21d / 12h</td>
<td>1 application per season</td>
</tr>
<tr>
<td>Danitol 2.4 EC</td>
<td>fenpropathrin</td>
<td>16.0 oz</td>
<td><strong>82% / 67</strong></td>
<td>14d PF; 3d SF / 24h</td>
<td>2-3 application per season</td>
</tr>
<tr>
<td>Vydate L</td>
<td>oxamyl</td>
<td>6.0 pt</td>
<td><strong>82% / 34</strong></td>
<td>14d / 48h</td>
<td>Apply/pear only; 1 application @ tested rate</td>
</tr>
</tbody>
</table>

- direct contact bioassays @120 h after treatment; ** - dry residual bioassays (T. Leskey, USDA ARS)

PF – pome fruit; SF – stone fruit
BMSB Monitoring

• Presence, abundance, & seasonal activity
• Sweep nets/ beating trays
• Black light traps
• Pyramid traps
  • Aggregation pheromone identified

Main component of BMSB aggregation pheromone
(3S,8S,7R,10S)-10,11-epoxy-1-bisabol-3-ol

Minor component of BMSB aggregation pheromone
(3R,8S,7R,10S)-10,11-epoxy-1-bisabol-3-ol

Methyl (E,E,2)-2,4,8-decatrinooate (MDT) acts as a synergist for BMSB pheromone

Synergism
Pheromone Trapping

Black Pyramid traps with the Tréce dual lures

• T. Leskey et al. 2014 (USDA ARS WV) found that a threshold of 10 BMSB/trap/week resulted in the same level of injury to apples as weekly BMSB sprays and reduced the number of applications by 40%. Two years of data.
BMSB is an IPM Disrupter

Effective insecticides damage predators of other pests

- may promote outbreaks of other secondary pests

Need to limit these applications to only as needed
Relief in the Future

• Also came to US accidently as well
• Found in NY, MD, VA, NJ, DC, WA, PA, OR
• Kills 50% or more of BMSB eggs in Asia

“Samurai” wasp

Parasitized eggs die and turn black
Rosy Apple Aphid

Several years since it has been a problem
  - due to change in chemicals?
  - due to Esteem at ½” green for SJS?
  - delayed dormant oil?
Rotating to Different Modes of Action - Apples

Numbers represent IRAC Mode of Action groups

- Insecticides
  - 4A Actara
  - Admire
  - Assail
  - Belay
  - 1A Sevin
  - Lannate
  - Vydate
  - 23 Movento
  - 29 Beleaf
  - 18 Confirm
  - Intrepid
  - 3 Asana
  - Baythroid
  - Danitol
  - Pounce
  - Proaxis
  - Warrior
  - 28 Altacor
  - Exirel
  - 7C Esteem
  - 16 Centaur
  - 4D Sivanto
  - 6 Proclaim

- Miticides
  - 21A Nexter
  - 12B Vendex
  - 23 Envidor
  - 10A Apollo
  - Savey
  - 10B Zeal
  - 21 Portal
  - 25 Nealta
  - 23 Movento
  - 20B Kanemite
  - UN Acramite
  - 24 Closer

- Additional entries:
  - 1B Diazinon
  - Imidan
  - Lorsban
  - Spuracide
  - 5 Entrust
  - Delegate
  - 22 Avaunt
  - 15 Rimon
  - 23 Movento
  - 12B Movento
  - 12B Vendex
  - 4C Closer