Improved Management of Cotton Aphids in SJV Crops: Importance of Overwintering Populations in Pomegranates

Larry D. Godfrey\textsuperscript{1}, Elizabeth Grafton-Cardwell\textsuperscript{2}, Kris Lynn-Patterson\textsuperscript{3}, Kristine E. Godfrey\textsuperscript{4,5}

\textsuperscript{1}UC Davis, \textsuperscript{2}UC Riverside, \textsuperscript{3}Kearney Agricultural Center, Parlier, CA, \textsuperscript{4}California Dept of Food & Agriculture, Sacramento, CA, \textsuperscript{5}Contained Research Facility, Univ. of California, Davis, CA
• melon aphid, cotton aphid, other common names
• at least 300 host plants are known in the U.S. and perhaps 700 host plants world-wide

• citrus, eggplant, celery, floriculture and ornamental nurseries, melons, squash, cotton, pomegranates, and dry beans are important crop hosts in California
Cotton Aphid

• **Damage**
  - reduction / distortion of plant growth – many crops
  - contamination of produce – many crops
  - virus transmission – cucurbits (cucumber mosaic & others), citrus (Tristeza disease complex)
Number of CTV-infected trees removed at the Lindcove Research and Extension Center Collection in April-May

- **Research Blocks**
- **Foundation Block**

**Treatments:**
- Spring 2009-2012: LREC (Assail)
- Fall 2008-2012: LREC + 2 mile (Admire)
Annual Crops

• Aphid problems continue on cotton, melons, squash, etc.

• insecticidal control relies on neonicotinoid insecticides
  – under scrutiny due to honey bee concerns
  – resistance reported in cotton aphid from other states
Not a new insect to CA

- 1990’s- saw early-season (spring) infestations of cotton aphids in the eastern Tulare Co. area first
- Gordon Smith, 1942. “…certain localities at the southern extremity of the San Joaquin Valley and along the eastern side of the valley have this pest to contend with throughout the growing season almost every year.”
- What is unique about this area?
Project objectives

1. Investigate the phenology and life history of cotton aphid
   • Monitor populations
   • Degree day predictions
2. Investigate reduced-risk insecticide efficacy
3. Non-chemical management of cotton aphids
   • Pheromones
   • Biological control
4. Map pomegranate and citrus acreage
5. Extend results

Funding from USDA/CFDA Specialty Crop Block Grant Program
Primary Host – pomegranate
Secondary Host – citrus, melons, eggplants, cotton, ornamentals, etc.
Aphis gossypii Overwintering

- Female
- Male

Fundatrices or first generation aphids eclosed from eggs
Rocky Hill 17-B
2010

![Aphid stage per twig graph](image)
Aphid stage per twig

- Unhatched eggs
- Hatched Eggs
- Nymphs
- Winged nymphs
- Alate

Lemon Cove
2009-2010

Graph showing the aphid stages per twig with peaks in April for 1st nymphs and 1st winged nymphs.
<table>
<thead>
<tr>
<th></th>
<th>Lemon cove</th>
<th>RH 22-9</th>
<th>RH17-8</th>
<th>Berghius</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st nymphs on twigs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>March 10</td>
<td>Feb 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>-</td>
<td>Mar 9</td>
<td>Jan 20</td>
<td>Feb 9</td>
</tr>
<tr>
<td>2011</td>
<td>-</td>
<td>Mar 14</td>
<td>Mar 14</td>
<td></td>
</tr>
<tr>
<td><strong>1st winged nymph</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>April 14</td>
<td>April 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>-</td>
<td>March 22</td>
<td>March 22</td>
<td>Mar 29</td>
</tr>
<tr>
<td>2011</td>
<td>April 4</td>
<td>April 4</td>
<td>March 30</td>
<td></td>
</tr>
</tbody>
</table>

Assail treatment program in citrus: last two weeks of March (prior to bloom)
Cotton aphid as vector of citrus tristeza virus

- Cotton aphid
- Citrus tristeza virus-infected citrus tree
- Spread citrus tristeza virus to other citrus trees
Kern Co. and southern Tulare Co. sites

- none
- no eggs, aphids in spring
2010-11

Average of Kern Co. and southern Tulare Co. sites

- yellow eggs
- black eggs
- hatched eggs
- nymphs
- nymphs with wingpads
- apterous adults
- alate adults

Number per 12" Twig

0 5 10 15

Sooty mold on pomegranate due to aphids

A. gossypii egg on pomegranate leaf bud
Environmental Effects on Egg Hatch

• Collect aphid eggs from pomegranates in Tulare Co.
• Collect them as soon after oviposition as possible
• Expose in Davis lab to:

<table>
<thead>
<tr>
<th>Cold Period</th>
<th>Temperature</th>
<th>Duration</th>
<th>Hatching temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>none</td>
<td>none</td>
<td>86 °F</td>
</tr>
<tr>
<td></td>
<td>34 °F</td>
<td>1, 2, or 3 months</td>
<td>55, 59, 68, 77, or 86 °F</td>
</tr>
<tr>
<td></td>
<td>43 °F</td>
<td>1, 2, or 3 months</td>
<td>55, 59, 68, 77, or 86 °F</td>
</tr>
<tr>
<td></td>
<td>Outdoors (Davis)</td>
<td>1, 2, or 3 months</td>
<td>55, 59, 68, 77, or 86 °F</td>
</tr>
</tbody>
</table>
Environmental Effects on Egg Hatch

Mean Eclosion Success at 68°F, 2010-2011

<table>
<thead>
<tr>
<th>Holding Regime</th>
<th>NO HOLDING</th>
<th>30 days</th>
<th>60 days</th>
<th>90 days</th>
<th>30 days</th>
<th>60 days</th>
<th>90 days</th>
<th>30 days</th>
<th>60 days</th>
<th>90 days</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 °C</td>
<td>1 °C</td>
<td>1 °C</td>
<td>6 °C</td>
<td>6 °C</td>
<td>6 °C</td>
<td>Outdoors</td>
<td>Outdoors</td>
<td>Outdoors</td>
</tr>
<tr>
<td></td>
<td>4.22</td>
<td>5.86</td>
<td>8.58</td>
<td>0.00</td>
<td>13.92</td>
<td>22.28</td>
<td>37.75</td>
<td>24.67</td>
<td>21.28</td>
<td>17.59</td>
</tr>
</tbody>
</table>

Mean eclosion %
Environmental Effects on Egg Hatch

Hatching Success: Holding = 43 °F, 60 Days

% eggs hatched

Incubation Temperature °C

13 15 20 25 30
Environmental Effects on Egg Hatch

Development from Hatch to Adult

Estimated min. developmental temp = 37 °F
Degree days needed to adult = 403
Management

- Insecticides
- Biological control
- Pheromones
Pomegranate trial, Woodlake CA 2008, 10 oz Movento/acre in 90 gals of water. Movento is foliarly systemic and so takes time to act but works very well on cotton aphids.

Movento IR-4 request – data completed
2013 EPA registration likely for aphids in pomegranates
Potential Insecticide Registrations/uses for Pomegranates
Insecticides tested against cotton aphid in citrus and found to be effective

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Chemical</th>
<th>Chemical group</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provado 1.6 or Admire Pro</td>
<td>2.8 oz 7-14 oz</td>
<td>Imidacloprid</td>
<td>4A</td>
<td>Registered as foliar and systemic. Systemic works best in the fall.</td>
</tr>
<tr>
<td>Actara 25 WG</td>
<td>5.5 oz</td>
<td>Thiamethoxam</td>
<td>4A</td>
<td></td>
</tr>
<tr>
<td>Assail 30 SG</td>
<td>4.7 oz</td>
<td>Acetamiprid</td>
<td>4A</td>
<td></td>
</tr>
<tr>
<td>Closer</td>
<td>2.8 oz</td>
<td>Sulfoxaflor</td>
<td>4C</td>
<td></td>
</tr>
<tr>
<td>Bexar</td>
<td>27 oz</td>
<td>Tolfenpyrad</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Altacor</td>
<td>3 oz</td>
<td>Chlorantraniliprole</td>
<td>28</td>
<td>Labeled for orangeworm and leafroller in pomegranates. Soft on beneficials.</td>
</tr>
</tbody>
</table>

E. Grafton-Cardwell trials during 2009-2012
Rocky Hill 17-B 2010

Aphid Parasitoids
Sites near Lindcove REC

Number of Parasitoids per 100 Aphids

- Lysiphlebus
- Aphelinus
- Charipidae
- Pteromalidae

Graph showing the number of parasitoids per 100 aphids from May 5 to August 13, 2010, with peaks in June 4 and June 18.
Pheromone Uses for Aphid Management

- Since both sexes are present in fall, they use pheromones to communicate, i.e., males finding females
- Different aphid species use different ratios of nepetalactone and nepetalactol

1. nepetalactone
2. nepetalactol
3. nepetalactone and nepetalactol (1:1)
4. none
Aphid Sex Pheromones
2012
“A. gossypii” only

nepetalactone
nepetalactol
nepetalactone and nepetalactol
control

17-Nov 23-Nov 29-Nov 7-Dec
Map pomegranate and citrus acreage in SJV; determine areas of overlap

Completed Survey:

268 square miles

406 individual fields

29935 total acres
Citrus proximity to pomegranates: 0.5 mi

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<th>Acres Effected</th>
<th>% Effected</th>
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<td>0.5 mi</td>
<td>51595</td>
<td>24%</td>
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<tr>
<td>1 mi</td>
<td>86655</td>
<td>40%</td>
</tr>
<tr>
<td>2 mi</td>
<td>146442</td>
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Citrus proximity to pomegranates: 1.0 mi

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Citrus proximity to pomegranates: 2.0 mi
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