Walnut Scale & Walnut Husk Fly

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Sac-Solano-Yolo Walnut Day
Feb 23rd, 2016
Life Cycle and Management of Walnut Scale

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Walnut Scale Basic Biology

- Eggs (under female cover)
- Adult males
- Nymphs (immobile)
- Crawlers (mobile)
Impact of Walnut Scale

- Suck plant juices
- Infested trees can appear water stressed
- Heavy populations may cause dieback of inside fruiting wood on lateral bearing cultivars, cracking of bark, reduced terminal growth & vigor leading to smaller nuts & poor kernel quality
- Economic damage rare unless populations very heavy, but…
- ***Feeding can provide entry point for pathogens
  - Ex: Bot-walnut scale association
Impact of Walnut Scale

Association with *Botryosphaeria*
Walnut Scale Seasonal Cycle*

- Two generations/year
- Overwinter as 2nd instar nymphs
- Resume development late winter – spring
- 1st generation crawler emergence late April – early May
- 2nd generation crawlers late summer – fall

*Phenology model pieced together from limited studies and are approximate timings only.
## 2015 Phenology Study

<table>
<thead>
<tr>
<th>Site</th>
<th>Cultivar</th>
<th>Number of replicate tapes (total trees)</th>
<th>Parasitoid activity detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tehama 1</td>
<td>Howard</td>
<td>4 (4)</td>
<td>Yes</td>
</tr>
<tr>
<td>Butte 3</td>
<td>Chandler</td>
<td>10 (5)</td>
<td>Yes</td>
</tr>
<tr>
<td>Butte 4</td>
<td>Howard</td>
<td>10 (5)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yuba 5</td>
<td>Vina</td>
<td>12 (6)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yuba 6</td>
<td>Chandler</td>
<td>18 (6)</td>
<td>Yes</td>
</tr>
<tr>
<td>Solano 7</td>
<td>Chandler</td>
<td>12 (9)</td>
<td>Yes</td>
</tr>
<tr>
<td>Contra Costa 10</td>
<td>Chandler</td>
<td>12 (6)</td>
<td>Yes</td>
</tr>
<tr>
<td>Contra Costa 11</td>
<td>Chandler</td>
<td>12 (6)</td>
<td>Yes</td>
</tr>
<tr>
<td>Tulare 12</td>
<td>Chandler</td>
<td>10 (5)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
2015 Phenology Study – Crawler Monitoring

Appr. 100X magnification

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2015 Phenology Study – General Conclusions

- 2 generations/year in all locations
- Extended crawler periods
  - Appears to be more overlap between generations than previously reported
Biological Control: Walnut Scale Parasitoids
Twicestabbed lady beetle adult and larva

Cybocephalus californicus beetle
Walnut Scale Monitoring: Dormant Period

- Examine scaffolds, limbs, branches, and prunings for scales & evidence of parasitism

- Historical treatment thresholds: pests + parasitization
  - If high degree of parasitization observed, consider delaying treatments until after crawler emergence

- Current thresholds – must consider Botryosphaeria

***If treatments were applied previous season, confirm whether scales are still alive***
Walnut Scale Monitoring: Dormant Period

Live walnut scale nymphs (above)
Live walnut scale adult females (below)

Dead adult female walnut scale
Walnut Scale Monitoring: Crawlers

- Place tapes by mid-April
- Monitor weekly
- Aid in treatment timing
- Confirm live populations
- Assess population densities
Walnut Scale Monitoring: Dormant Period

Appr. 100X magnification

Often high densities at margins of tape (low magnification)

Photos: E. J. Symmes (L) and D. M. Lightle (R)
Walnut Scale Management Options & Timing

• Pre-Bot: Biological control provided adequate suppression of low to moderate populations

• Bot-era: Insecticide treatment timings
  • Delayed-dormant (March)
  • Crawler stage
2014-2015 Insecticide Evaluations

- ‘Vina’ walnut orchard, Yuba County, CA

- Treatment timings
  - Post-delayed dormant or first generation crawler

- Each tree monitored for crawlers
  - 25-March-2014 to 2-June-2014

- During dormant season, twigs examined for number of live scales
  - 21-January-2015

- Follow-up crawler evaluations
  - 4-June-2015 and 11-June-2015
### 2014-2015 Insecticide Evaluations

<table>
<thead>
<tr>
<th>Treatment (AI)*</th>
<th>Rate form/acre</th>
<th>IRAC # (Mode of Action)</th>
<th>Application Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Check</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Seize 35WP (pyriproxyfen)</td>
<td>5.0 oz.</td>
<td>7C (IGR – juvenile hormone mimic)</td>
<td>DD</td>
</tr>
<tr>
<td>Centaur 70WDG (buprofezin)</td>
<td>46.0 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>DD</td>
</tr>
<tr>
<td>Sequoia 2SC (sulfoxaflor)</td>
<td>5.75 fl. oz.</td>
<td>4C (sulfoximine – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Assail 30SG (acetamiprid)</td>
<td>5.3 oz.</td>
<td>4A (neonicotinoid – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Assail 30SG (acetamiprid)</td>
<td>9.6 oz.</td>
<td>4A (neonicotinoid – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Movento 2SC (spirotetramat)</td>
<td>9.0 fl. oz.</td>
<td>23 (IGR – lipid biosynthesis inhibitor)</td>
<td>C</td>
</tr>
<tr>
<td>Brigadier 2EC (bifenthrin + imidacloprid)</td>
<td>12.8 fl. oz.</td>
<td>3 and 4A (pyrethroid + neonicotinoid – nerve toxins)</td>
<td>C</td>
</tr>
<tr>
<td>Centaur 70WDG (buprofezin)</td>
<td>46 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>C</td>
</tr>
</tbody>
</table>

*All treatments included 0.25% v/v Latron B-1956

DD = (post) delayed-dormant (8-April-2014)
C = crawler (6-May-2014)
2014-2015 Insecticide Evaluations

2014-2015
Total crawlers/cm/day

<table>
<thead>
<tr>
<th>Product</th>
<th>Treatment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated check</td>
<td>Delayed dormant</td>
</tr>
<tr>
<td>Seize 35WP</td>
<td></td>
</tr>
<tr>
<td>Centaur 70WDG</td>
<td></td>
</tr>
<tr>
<td>Sequoia 2SC</td>
<td>Crawler treatments</td>
</tr>
<tr>
<td>Assail 30SG, low rate</td>
<td></td>
</tr>
<tr>
<td>Movento 2SC</td>
<td></td>
</tr>
<tr>
<td>Brigadier 2EC</td>
<td></td>
</tr>
<tr>
<td>Centaur 70WDG</td>
<td></td>
</tr>
<tr>
<td>Assail 30SG, high rate</td>
<td></td>
</tr>
</tbody>
</table>

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### 2014-2015 Insecticide Evaluations

**Live scale/cm – January 2015**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Crawler treatments</th>
<th>Delayed dormant treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seize 35WP</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>Centaur 70WDG</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>Sequoia 2SC</td>
<td>bc</td>
<td></td>
</tr>
<tr>
<td>Assail 30SG, low rate</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>Movento 2SC</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>Brigadier 2EC</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>Centaur 70WDG</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>Assail 30SG, high rate</td>
<td>bc</td>
<td></td>
</tr>
</tbody>
</table>

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2014-2015 Insecticide Evaluations

2014-2015
Crawlers/cm/day – June 2015

- Untreated check: a
- Seize 35WP: c
- Centaur 70WDG: bc
- Sequoia 2SC: ab
- Assail 30SG, low rate: bc
- Movento 2SC: bc
- Brigadier 2EC: bc
- Centaur 70WDG: c
- Assail 30SG, high rate: bc

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2014-2015 Insecticide Evaluations

- General Conclusions

- Centaur 70WDG (delayed dormant) provided best control of within-generation crawlers

- Centaur 70WDG (delayed dormant & crawler), Seize 35WP (delayed dormant), Movento 2SC (crawler), and Brigadier 2EC (crawler) provided best control based on OW populations

- All treatments except Sequoia 2SC provided significant population suppression the following spring compared to UTC
2015-2016 Insecticide Evaluations

- ‘Chandler’ walnut orchard, Yuba County, CA

- Treatment timings
  - Delayed dormant and/or first generation crawlers

- Each tree monitored for crawlers
  - 14-April-2015 to 25-June-2015

- During dormant season, twigs examined for number of live scales
  - January 2016
## 2015-2016 Insecticide Evaluations

<table>
<thead>
<tr>
<th>Treatment (AI)</th>
<th>Rate form/acre</th>
<th>Mode of Action (IRAC #)</th>
<th>Application Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Check</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Seize 35WPb (pyriproxyfen)</td>
<td>5.0 oz.</td>
<td>7C (IGR – juvenile hormone mimic)</td>
<td>DD</td>
</tr>
<tr>
<td>Centaur 70WDGb (buprofezin)</td>
<td>46.0 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>DD</td>
</tr>
<tr>
<td>Centaur 70WDGc (buprofezin)</td>
<td>46.0 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>DD</td>
</tr>
<tr>
<td>Centaur 70WDGcd (buprofezin)</td>
<td>46.0 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>DD</td>
</tr>
<tr>
<td>Sivanto 1.67SLa (flupyradifurone)</td>
<td>14.0 fl. oz.</td>
<td>4D (butenolide – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Sequoia 2SCa</td>
<td>4.5 fl. oz.</td>
<td>4C (sulfoximine – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Sequoia 2SCa</td>
<td>5.75 fl. oz.</td>
<td>4C (sulfoximine – nerve toxin)</td>
<td>C</td>
</tr>
<tr>
<td>Movento 2SCa (spirotetramat)</td>
<td>9.0 fl. oz.</td>
<td>23 (IGR – lipid biosynthesis inhibitor)</td>
<td>C</td>
</tr>
<tr>
<td>Centaur 70WDGa (buprofezin)</td>
<td>46 oz.</td>
<td>16 (IGR – chitin synthesis inhibitor)</td>
<td>C</td>
</tr>
<tr>
<td>Sivanto 1.67 SLb (flupyradifurone)</td>
<td>14.0 fl. oz.</td>
<td>4D (butenolide – nerve toxin)</td>
<td>DD</td>
</tr>
<tr>
<td>Movento 2SCa (spirotetramat)</td>
<td>9.0 fl. oz.</td>
<td>23 (IGR – lipid biosynthesis inhibitor)</td>
<td>C</td>
</tr>
<tr>
<td>Movento 2CS (spirotetramat) + Assail 30SGa (acetamiprid)</td>
<td>9.0 fl. oz. + 8.0 fl. oz.</td>
<td>23 (IGR – lipid biosynthesis inhibitor) 4A (neonicotinoid – nerve toxin)</td>
<td>C</td>
</tr>
</tbody>
</table>

---

* Treatments included 0.0625% v/v Dyne-Amic  
* Treatments included 0.25% v/v Latron B-1956  
* Treatments included 0.5% v/v OR 009  
* Treatments included 0.0125% v/v Latron B-1956  

DD = delayed-dormant (12-March-2015)  
C = crawler (12-May-2015)
2015-2016 Insecticide Evaluations

2015-2016
Total crawlers/cm/day

Untreated Check

Seize 35WP

cde

Centaur 70WDG (OR 009)
de

Centaur 70WDG (Latron B-1956)
de

Centaur 70WDG (OR 009 + Latron B-1956)
e

Sivanto 1.67SL

cde

Sequoia 2SC, low rate
ab

Sequoia 2SC, high rate
bcd

Movento 2SC
cde

Centaur 70WDG
cde

Sivanto 1.67SL (dormant) + Movento 2SC (crawler)
bc

Movento 2SC (crawler) + Assail 30SG (crawler)
cde

Delayed dormant treatments

Crawler treatments

Combination treatments

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2015-2016 Insecticide Evaluations

2015-2016
Live scale/cm – January 2016

Untreated Check

Seize 35WP

Centaur 70WDG (OR 009)

Centaur 70WDG (Latron B-1956)

Centaur 70WDG (OR 009 + Latron B-1956)

Sivanto 1.67SL

Sequoia 2SC, low rate

Sequoia 2SC, high rate

Movento 2SC

Centaur 70WDG

Sivanto 1.67SL (dormant) + Movento 2SC (crawler)

Movento 2SC (crawler) + Assail 30SG (crawler)

Delayed dormant treatments

Crawler treatments

Combination treatments

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## General Conclusions

- Spring 2015 evaluations showed continued population suppression
  - Possible every 2-3 year treatment for scale
- Spring 2016 evaluations...
- Treatment thresholds based on Bot pressure?

### 2014-2016 Insecticide Evaluations

<table>
<thead>
<tr>
<th>Generally performed better than untreated:</th>
<th>Mixed results (relative to controls):</th>
<th>Did not perform well (relative to controls):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seize DD</td>
<td>Assail C</td>
<td>Sivanto C</td>
</tr>
<tr>
<td>Centaur DD</td>
<td>Brigadier C</td>
<td>Sequoia* C</td>
</tr>
<tr>
<td>Centaur C</td>
<td>Movento C</td>
<td></td>
</tr>
</tbody>
</table>
Walnut Husk Fly Management Update

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Insecticide Efficacy Trials – Van Steenwyk & Coates

• ‘Hartley’ orchard (Hollister, CA)

• High WHF populations

• Treatments applied with hand-gun orchard sprayer
  - Operated at 250 psi, final spray volume of 300 gal/ac

• 3 to 4 applications/year
  - Mid-late July, mid-August, late-August/early-September

• Treatments replicated 4 times (single tree replicates)
  - Included NuLure & Dyne-Amic or Latron-B

• Evaluated 125 nuts/rep before commercial harvest (mid-
<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leverage 360</strong></td>
<td>2.8 fl.oz/acre betacyfluthrin (3A) and imidacloprid (4A)</td>
</tr>
<tr>
<td><strong>Assail</strong></td>
<td>6.0 oz/acre acetamiprid (4A)</td>
</tr>
<tr>
<td><strong>Danitol + Belay</strong></td>
<td>21.3 fl.oz + 6 fl.oz/acre fenpropadrin (3A) + clothianidin (4A)</td>
</tr>
</tbody>
</table>
| **Stallion + Brigadier** | 11.8 fl.oz + 12.8 fl.oz/acre  
 bifentrin (3A) and imidaclorid (4A) + zeta-cypermethrin (3A) and chlorpyrifos (1B) |
| **Baythroid**        | 2.8 fl.oz/acre betacyfluthrin (3A)               |
## Good Efficacy
### 75-95% Control

<table>
<thead>
<tr>
<th>Product</th>
<th>Concentration</th>
<th>Active Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temitry</td>
<td>14.0 oz/acre</td>
<td>malathion (1B) and gamma-cyhalothrin (3A)</td>
</tr>
<tr>
<td>Danitol</td>
<td>21.3 fl.oz/acre</td>
<td>fenpropathrin (3A)</td>
</tr>
<tr>
<td>Belay</td>
<td>6.0 fl.oz/acre</td>
<td>clothianidin (4A)</td>
</tr>
<tr>
<td>Assail</td>
<td>4.0 oz/acre</td>
<td>acetamiprid (4A)</td>
</tr>
<tr>
<td>Athena + Brigadier</td>
<td>20.0 fl.oz + 12.8 fl.oz/acre</td>
<td>bifenthrin (3A) and avermectin (6) + zeta-cypermethrin (3A) and chlorpyrifos (1B)</td>
</tr>
<tr>
<td>Brigade + Brigadier</td>
<td>16.0 oz + 12.8 fl.oz/acre</td>
<td>bifenthrin (3A) + zeta-cypermethrin (3A) and chlorpyrifos (1B)</td>
</tr>
<tr>
<td>Provado</td>
<td>7.0 fl.oz/acre</td>
<td>imidacloprid (4A)</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Moderate Efficacy</th>
<th>50-75% Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Athena</strong></td>
<td>20.0 fl.oz/acre</td>
</tr>
<tr>
<td></td>
<td>bifenthrin (3A)</td>
</tr>
<tr>
<td><strong>Intrepid Edge</strong></td>
<td>12.75 fl.oz/acre</td>
</tr>
<tr>
<td></td>
<td>spinetoram (5) and methoxyfenozide (18)</td>
</tr>
<tr>
<td><strong>Warrior</strong></td>
<td>2.56 fl.oz/acre</td>
</tr>
<tr>
<td></td>
<td>lambda-cyhalothrin (3A)</td>
</tr>
<tr>
<td><strong>Belay</strong></td>
<td>3.0 fl.oz/acre</td>
</tr>
<tr>
<td></td>
<td>clothianidin (4A)</td>
</tr>
<tr>
<td><strong>Delegate</strong></td>
<td>3.2 oz/acre</td>
</tr>
<tr>
<td></td>
<td>spinetoram (5)</td>
</tr>
<tr>
<td>Little Efficacy 20-50% Control</td>
<td>No Efficacy 0-20% Control</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Cyclaniliprole (28)</strong> 16.4 fl.oz/acre</td>
<td><strong>Malathion (1B)</strong> 64.0 fl.oz/acre</td>
</tr>
<tr>
<td><strong>Exirel</strong> 20.5 fl.oz/acre cyantraniliprole (28)</td>
<td><strong>Bexar</strong> 27.0 fl.oz/acre tolfenpyrad (21A)</td>
</tr>
<tr>
<td></td>
<td><strong>Altacor</strong> 4.0 oz/acre chlorantraniliprole (28)</td>
</tr>
</tbody>
</table>

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Nuts exposed to WHF – ave. 3 stings/nut

Nuts dipped in max. label rate/100 gal., air dried, visually examined for egg hatch/larval feeding 3, 7, 10 days after treatment
- Immediately after oviposition
- 7-10 days later (after larval feeding observed)

3 treatments (neonicotinoids, 3A) + UTC, 20 replicates
- Assail 30SG (2.4 fl. oz) – acetamiprid
- Admire Pro (8.0 oz) – imidacloprid
- Belay 2.13SC (6.0 fl. oz) – clothianidin
- All with 0.125% v/v MSO (methylated seed oil)
• General conclusions

• All tested materials showed ovicidal activity
  - Very high exposure with dip method
  - Need to follow-up with exposure rates typical of field application methods

• Larvicidal activity not observed
  - Suggests that, once hatched, larvae are highly resistant to surface application of these materials

• Control at various life stages enables more leeway in spray timing
Walnut Husk Fly
Management Update

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