Pest Management Update: Insects, Disease and Weeds

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UC Riverside
2013 Headlines in Almond Entomology

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UC Cooperative Extension- Kern Co.
2013 Headlines

1) Spider mites in the Lower San Joaquin Valley
2) Pesticide use trends - judicious pyrethroid use
3) Utilizing pheromone traps for navel orangeworm
Long-term trends in miticide use

- Miticide applications per acre are 2-3X higher than 10 years ago
- This is despite the registration of improved miticides
- The tolerance for mites has decreased
- Threshold-based programs are being replaced by calendared and preventative programs
- Greatest increase in miticide use is in May (abamectin)
Factors outside of our control

• Minimal rain
  – Good overwintering survival of mites
  – Dust on leaves promotes mites
  – Dust affects coverage
  – Translaminar activity of miticides is neutralized

• Erratic/warm spring weather
  – Mites got started a month early
  – Emergence of mites not synchronized (some early, some later)
  – Beneficial organisms seemed out of sync with mites
  – Mites moved from the crotch to the tree canopy quicker than normal
Factors within our control

• Coverage issues
  – Insufficient water volumes
  – Driving too fast (>2mph) to cover lots of acreage in a short amount of time

• Early application timings
  – Many miticides tank mixed with a 1st flight NOW spray in mid to late-April

• Impacts to biological control
  – Coming off of an all-time record year for pyrethroids at hull split in 2012
  – Many pyrethroids used in April 2013
  – Almonds blanketed with abamectin-based miticides that kill the primary predator in almonds (sixspotted thrips)
What happened in 2013

Results

• Widespread mite outbreaks throughout the lower SJV in May and June
• Common for orchards to be sprayed 2-3X by mid-June
• Widespread miticide ‘failures’ reported in June
• Many trees green (bottom two thirds) and brown and webbed on the top
What happened in 2013

**Results**

- Widespread mite outbreaks throughout the lower SJV in May and June
- Common for orchards to be sprayed 2-3X by mid-June
- Widespread miticide ‘failures’ reported in June
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**But.......**

- Please ask a southern valley PCA how many mites they saw after July 1
- Mite survivors became predator food
- Thrips, lacewings, *Rhizobius*, and pirate bugs got established in treetops
- Miticides changed predator/prey ratios
- By hull split the mites were gone and they never came back
- Defoliation practically non-existent
- 2013 = best biocontrol year ever!
Ideal mite management programs

- Tolerate low mite population early in the season
- Biological control organisms get established
- Monitor mite densities (presence/absence on leaves)
- If less than 25 to 40% of leaves infested, do not treat, mites will reproduce geometrically and biocontrol can keep up
- If more than 25 to 40%, mite growth turns geometric and biocontrol cannot keep up, treat with a miticide that kills mites but maintains biocontrol organisms
- Miticide controls most of the mites, predators eat up any mites that survive
- Predator/prey ratios typically remain balanced for the rest of the season
## Pesticide use trends: Pyrethroids

### Advantages
- New-generation pyrethroids more effective than their predecessors
  - Increased photostability
  - Isomers more refined
- Inexpensive
  - Half the cost of the application
- Effective on a range of pests
  - NOW, PTB, OFM
  - San Jose Scale
  - Leaffooted bug and stink bug

### Concerns
- Toxic to predatory insects and mites
- Long persistence means long impacts on biocontrol
- Inexpensive price makes overuse easy
- History of resistance development
- Prone to causing secondary pest outbreaks
  - esp. mites and scale
Pesticide use trends - Pyrethroids

- Dormant treatments fairly static 2000 to 2011
- Southern Counties
  - April-May applications increased by 5X since 2005
  - Hull split applications increased by 4X since 2005
  - Data from 2012 and 2013 will be off the charts
- Northern Counties
  - April-May applications increased by 5X since 2005
  - Hull split applications increased by 2.5X since 2005

*Increases compare 2005 to 2011*
Correlation between Pyrethroid and Miticide Applications Per Acre Each Year

Each datapoint represents one year between 2000 and 2011

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Correlation between Pyrethroid and Miticide Applications Per Acre Each Year

Each datapoint represents one year between 2000 and 2011.

Each year, the data for pyrethroids per acre and miticides per acre are plotted. The trend line shows a positive correlation between the two variables. The data points for 2010 are plotted in blue squares, and the data points for 2011 are plotted in pink diamonds. The years 2012 and 2013 are marked with question marks, indicating that data for those years is not available.

The graph visually represents how the use of pyrethroids per acre is correlated with the use of miticides per acre, with a noticeable increase in both variables from 2010 to 2011.
Resistance assays

B. Higbee, PFC

48 hr mortality tables

<table>
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<tr>
<th>Year</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
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<td>2010</td>
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<td>5.4/5.3</td>
<td>6.6/6.1</td>
<td>4.0/3.9</td>
<td>4.8/4.5</td>
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</table>

RF=Resistance factor = \( \frac{LC_{50} \text{ of field strain}}{LC_{50} \text{ of USDA strain}} \)

Bifenthrin is evaluated as a surrogate for all pyrethroids (Brigade, other bifenthrin products, Danitol, Warrior II, Voliam XPress, Pounce, Ambush, other permethrins)
Judicious use of pyrethroids

- **Navel Orangeworm**
  - Start with a solid foundation of sanitation
  - Optimize treatment timings with trapping
  - Base post hull-split applications on data
  - Rotate a.i.s (Intrepid, Belt, Altacor, Delegate)

- **Peach Twig Borer**
  - Base treatments on monitoring and degree-days
  - Many non-pyrethroid insecticides effective in-season
  - Maximize use of dormant oil

- **San Jose Scale**
  - Treat only when needed (dormant spur samples)
  - Maximize use of parasitoids and dormant oil
  - Consider alternatives like Sieze and Centaur

- **Leaffooted bug and stink bug**
  - Base treatments on monitoring
  - Consider alternatives such as Lorsban or Belay
Navel Orangeworm Traps

• Reasons for trapping
  – Improve application timing
  – Treatment thresholds
  – Evaluate insecticide efficacy
  – Confirm trap shutdown within mating disruption
  – Determine moth sources (internal or external)
  – Compare moth density across seasons

• Different traps can serve different purposes
Egg, Pheromone, Virgin-baited female traps
Southern SJV Almonds

Trap Monitoring - 2013
Almonds

- Eggs
- Virgins
- Phero Lure

Mean number of eggs or males


B. Higbee, PFC
Egg, Pheromone, Virgin-baited female traps
Southern SJV Almonds

Trap Monitoring - 2013
Almonds

- Eggs
- Virgins
- Phero Lure

Mean number of eggs or males


B. Higbee, PFC
Egg and Pheromone traps in the North

Based on current recommendations
Trapping take-home messages

• Egg traps still valuable
  – Degree-day models are still based on egg traps

• Pheromone traps are available
  – Use in thresholds not established
  – May provide assistance with treatment timing
  – Better resolution than egg traps in 2^{nd}/3^{rd} flights
  – Creative uses are possible
    • Residual effects of insecticides that kill adults
    • Document shut-down in mating disruption orchards
  – Lures are good 5-6 weeks, traps should be checked weekly
  – Wing traps or Large Plastic Delta traps work with the lure
    • Choose one trap type and stick with it over time.
Almond Weed Control Update

Brad Hanson
UC Davis Weed Science
T&V weed science team

- **T&V research and extension focused**
  - Brad Hanson – Weed Extension Specialist
    - Chemical weed control, herbicide resistance, herbicide fate, methyl bromide
  - Lynn Sosnoskie - Project Scientist
    - Weed biology, ecology and resistance management
  - Sorkel Kadir - Visiting Scientist
    - Herbicide fate in plants and soil
  - Don Stewart - Staff Research Associate
    - IR-4 minor crop pesticide residue testing program
  - Seth Watkins – Staff Research Associate
    - Orchard and vineyard herbicide efficacy and crop safety evaluations
  - Marcelo Moretti - PhD Student
    - Mechanisms of resistance in glyphosate- and paraquat-resistant Conyza,
  - Andrew (Bob) Johnson - MS Student
    - Non-fumigant approaches for orchard re-plant issues, herbicide performance
  - Oscar Morales – undergrad lab assistant
  - UCCE and industry cooperators
### Tree & Vine herbicide registrations

Updated annually and available online - easiest way is to find it is on the UC Weed Science blog

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**Herbicide Registration on Horticultural Tree and Vine Crops** *(updated December 2012 - UC Weed Science)*

<table>
<thead>
<tr>
<th>Herbicide Common Name</th>
<th>Site of Action</th>
<th>Almond</th>
<th>Pecan</th>
<th>Walnut</th>
<th>Apricot</th>
<th>Plum</th>
<th>Grape</th>
<th>Date</th>
<th>Fig</th>
<th>Date</th>
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**Prenetemergence**

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<tr>
<th>Herbicide Common Name</th>
<th>Site of Action</th>
<th>Almond</th>
<th>Pecan</th>
<th>Walnut</th>
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<td>clove oil (Motsite)</td>
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## CA almond herbicide use

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<tr>
<th>Rank</th>
<th>Active Ingredient</th>
<th>2011 Treated Acreage</th>
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<td>1</td>
<td>glyphosate</td>
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<td>2</td>
<td>oxyfluorfen (Goal, Goaltender)</td>
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<tr>
<td>3</td>
<td>glufosinate (Rely)</td>
<td>281,930</td>
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<td>4</td>
<td>paraquat (Gramoxone Inteon)</td>
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<td>5</td>
<td>pendimethalin (Prowl H2O)</td>
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<td>oryzalin (Surflan, etc)</td>
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<td>rimsulfuron (Matrix)</td>
<td>52,577</td>
</tr>
<tr>
<td>12</td>
<td>penoxsulam (PindarGT)</td>
<td>46,035</td>
</tr>
</tbody>
</table>

* strip treatments! 760,000 A bearing almond (2011)
Resistance management
## Confirmed glyphosate resistance

<table>
<thead>
<tr>
<th>(grouped by genus)</th>
<th>USA</th>
<th>CA</th>
<th>WA</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmer amaranth and com. waterhemp</td>
<td>✅</td>
<td>✅</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Giant and common ragweed</td>
<td>✅</td>
<td>✅</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian fingergrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hairy fleabane and horseweed</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Sourgrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junglerice</td>
<td>✅</td>
<td></td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Goosegrass</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Wild poinsettia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italian and rigid ryegrass</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Ragweed parthenium</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Buckhorn plantain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnsongrass</td>
<td>✅</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liverseedgrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Junglerice – orchards and corn
SJV junglerice

Greenhouse dose response
- 0.75 lb ae/A use rate
- Up to 4x
- Photos taken 21 DAT
Species of concern - goosegrass

• Eleusine spp.
  – Goosegrass and threespike goosegrass
Three-spikes goosegrass
Resistance publications

• Recent series of UC IPM publications
  – Selection Pressure, Shifting Populations, and Herbicide Resistance and Tolerance
  – Glyphosate Stewardship: Maintaining the Effectiveness of a Widely Used Herbicide
  – Preventing and Managing Glyphosate-Resistant Weeds in Orchards and Vineyards
  – Managing Glyphosate-Resistant Weeds in Glyphosate-Resistant Crops
  – [Link](http://anrcatalog.ucdavis.edu/) (type “glyphosate” in the search box)
Tree & Vine weed management challenges

- Reliance on a few herbicide MOA
- Glyphosate-resistance is a different than other HRW
  - Some cases are non-target site, polygenic resistance, environmentally variable
- Simply “switching herbicides” may not be viable
  - Switch to what?
    - eg. glufosinate resistance in ryegrass in OR
- “Stacked” resistance to multiple herbicides
  - This is here in a limited manner already (gly-paraquat)
    - eg. Australia nontarget site resistance in ryegrass
Efficacy evaluations
PRE herbicide comparisons

- Untreated
- Roundup PwrMx - (twice)
- RU + Goal + Surflan
- RU + Pindar GT (3pt)
- RU + Prowl (4qt)
- RU + Chateau (10oz)
- RU + Prowl + Chateau
- RU + Prowl + Matrix
- RU + Alion (6.5oz)
- RU + Trellis (1.3lb)
- RU + Prowl (twice)
- RU + Pindar GT fb RU + Prowl

Bars represent different weed species and their effectiveness:
- lambsquarter _ Davis 122
- junglerice_Wasco 86
- fleabane_Delhi 95
- primrose_Delhi 95
Glyphosate-paraquat resistant fleabane – 14 DAT

% control

- untreated
- glyphosate
- glufosinate
- saflufenacil
- carfentrazone
- glyphosate + glufosinate
- glyphosate + saflufenacil
- glufosinate + saflufenacil
- glyphosate + carfentrazone
- glyphosate + paraquat
- paraquat
- glyphosate + rimsulfuron (2oz)
- glyphosate + rimsulfuron (2oz) + saflufenacil
- 2,4-D
- glyphosate + 2,4-D
- glufosinate + 2,4-D
GR junglerice – Wasco 28 DAT

<table>
<thead>
<tr>
<th>treatments</th>
<th>visual control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-untreated</td>
<td></td>
</tr>
<tr>
<td>2-Roundup Powermax 28 fl oz</td>
<td></td>
</tr>
<tr>
<td>3-Roundup Powermax 44 fl oz</td>
<td></td>
</tr>
<tr>
<td>4-Rely 280 48 fl oz</td>
<td></td>
</tr>
<tr>
<td>5-Rely 280 82 fl oz</td>
<td></td>
</tr>
<tr>
<td>6-Gramoxone SL 1.25 pt</td>
<td></td>
</tr>
<tr>
<td>7-Gramoxone SL 3 pt</td>
<td></td>
</tr>
<tr>
<td>8-Matrix 2 oz</td>
<td></td>
</tr>
<tr>
<td>9-Matrix 2 oz + Roundup</td>
<td></td>
</tr>
<tr>
<td>10-Pindar GT 1.5 pt</td>
<td></td>
</tr>
<tr>
<td>11-Pindar GT 1.5 pt + Roundup</td>
<td></td>
</tr>
<tr>
<td>12-Chateau 6 oz</td>
<td></td>
</tr>
<tr>
<td>13-Chateau 6 oz + Roundup</td>
<td></td>
</tr>
<tr>
<td>14-Fusilade ll 12 fl oz</td>
<td></td>
</tr>
<tr>
<td>15-Selectmax 16 fl oz</td>
<td></td>
</tr>
<tr>
<td>16-Poast 12 fl oz</td>
<td></td>
</tr>
<tr>
<td>17-Matrix 4 oz + Roundup</td>
<td></td>
</tr>
<tr>
<td>18-Goal 2XL 8 oz + Roundup</td>
<td></td>
</tr>
</tbody>
</table>
Table 10: Effect of herbicide treatment combinations on junglerice visual control, biomass, and stand 28 days after treatment in a 2013 almond orchard trial near Wasco, CA. (Moretti, Watkins, and Hanson)

<table>
<thead>
<tr>
<th>Nº</th>
<th>Treatment</th>
<th>active ingredient</th>
<th>rate</th>
<th>visual control %</th>
<th>biomass g/m²</th>
<th>Density plants/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>untreated control</td>
<td></td>
<td></td>
<td>0</td>
<td>256</td>
<td>558</td>
</tr>
<tr>
<td>2</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>1 lb ae/a</td>
<td>8</td>
<td>80</td>
<td>174</td>
</tr>
<tr>
<td>3</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>44 fl oz/a</td>
<td>3</td>
<td>109</td>
<td>305</td>
</tr>
<tr>
<td>4</td>
<td>Rely 280 + AMS</td>
<td>glufosinate</td>
<td>48 fl oz/a</td>
<td>78</td>
<td>24</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>Rely 280 + AMS</td>
<td>glufosinate</td>
<td>82 fl oz/a</td>
<td>70</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>Gramoxone SL + NIS</td>
<td>paraquat</td>
<td>1.25 pt/a</td>
<td>58</td>
<td>25</td>
<td>94</td>
</tr>
<tr>
<td>7</td>
<td>Gramoxone SL + NIS</td>
<td>paraquat</td>
<td>4 pt/a</td>
<td>80</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td>8</td>
<td>Matrix + NIS + AMS</td>
<td>rimsulfuron</td>
<td>2 oz/a</td>
<td>98</td>
<td>14</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>1 lb ae/a</td>
<td>99</td>
<td>9</td>
<td>48</td>
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<tr>
<td>10</td>
<td>Pindar GT + NIS + AMS</td>
<td>penox/oxyfl</td>
<td>1.5 pt/a</td>
<td>63</td>
<td>6</td>
<td>54</td>
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<tr>
<td>11</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>1 lb ae/a</td>
<td>67</td>
<td>23</td>
<td>45</td>
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<tr>
<td>12</td>
<td>Chateau + NIS + AMS</td>
<td>flumioxazin</td>
<td>6 oz/a</td>
<td>66</td>
<td>7</td>
<td>33</td>
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<tr>
<td>13</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>flumioxazin</td>
<td>6 oz/a</td>
<td>88</td>
<td>0</td>
<td>30</td>
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<tr>
<td>14</td>
<td>Fusilade II + AMS + COC</td>
<td>fluazifop</td>
<td>12 fl oz/a</td>
<td>95</td>
<td>29</td>
<td>23</td>
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<tr>
<td>15</td>
<td>Envoy + AMS</td>
<td>clethodim</td>
<td>16 fl oz/a</td>
<td>92</td>
<td>15</td>
<td>53</td>
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<tr>
<td>16</td>
<td>Poast + AMS+COC</td>
<td>sethoxydim</td>
<td>1.5 pt/a</td>
<td>90</td>
<td>0</td>
<td>91</td>
</tr>
<tr>
<td>17</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>1 lb ae/a</td>
<td>98</td>
<td>19</td>
<td>59</td>
</tr>
<tr>
<td>18</td>
<td>Roundup Powermax + NIS + AMS</td>
<td>glyphosate</td>
<td>1 lb ae/a</td>
<td>18</td>
<td>143</td>
<td>487</td>
</tr>
</tbody>
</table>

Tukey’s HSD (P = 0.05)

Abbreviations: NIS - non-ionic surfactant at 0.25 % V/V; AMS - ammonium sulfate 10 lbs/100 gallons; COC - crop oil concentrate 1 % V/V; penox/oxyfl – penoxsulam / oxyfluorfen
A few product updates

- **PRE**
  - flazasulfuron
  - indaziflam
  - penoxsulam
  - rimsulfuron
  - isoxaben

- **POST**
  - glufosinate
  - saflufenacil
  - pyraflufen
  - graminacides
Almond Pathology:
Bacterial Spot
Almond Cankers
Biocontrol of Aflatoxins – AF36

Themis J. Michailides
UC Davis
Kearney Agricultural Research and Extension Center

David A. Doll
University of California – Cooperative Extension, Merced County

Cooperators: Several farm advisors and PCAs
John Edstrom, Farm Advisor in Colusa Co., observed the devastation of Fritz by the Bacterial Spot during his sabbatical leave to Australia in 2003.

In 2006, he detected symptoms resembling bacterial spot in Neplus almonds in Colusa Co. and sent two samples to my lab for diagnosis.

We isolated consistently the pathogen (Xanthomonas sp., a bacterium) causing bacterial spot of almond, and reported the diagnosis to the farm advisor (May 2006).
Inside this issue....

Another New Almond Disease?
Blistered Almonds Leaves
Leaffooted Plant Bug
Safety Note—Heat Stress Awareness

Another New Almond Disease?

The University of California in accordance with its policy of\nnon-discrimination, welcomes all qualified applicants, whatever\ntheir race, color, religion, sex, national origin, disability, or \nage.
2006: sample # First Report: John Edstrom,

2010: 1 sample, Roger Duncan, Farm Advisor, Stanislaus Co.: Again the pathogen was isolated and reported to the farm advisor.

2012: 2 samples, Roger Duncan: #12027 & #12031 (May 2012).

2013: more samples, D. Doll, R. Duncan, & B. Holtz: samples #13054, #13060, #13095.

First reports on new diseases should not be ignored!
✓ Pathogen: *Xanthomonas arboricola pv. pruni*
✓ Koch’s postulates have been completed

**Fruit lesions**

**Leaf lesions**
Lesions under the sap
Twig lesions
Premature fruit drop
Overwintering

A) On mummies
B) Buds
C) twig lesions
Bacterial Spot of Almonds

(Xanthomonas campestris pv. pruni)

INTRODUCTION

Bacterial spot is a disease caused by the bacterium Xanthomonas campestris pv. pruni (Xcp). First confirmed as present on almonds in Australia in 1994/95, this disease had previously been observed in 1993/94 in South Australia and possibly earlier. The similarity of leaf and nut symptoms of this disease and those of fungal 'shot-hole' in all likelihood allowed this disease to go unrecognized as a new disease for sometime prior to 1993. Many growers have first been alerted to the disease in their orchards, after 'ineffective shot-hole chemical applications'.

By 1996/97, Bacterial Spot had been confirmed as present on almonds in South Australia, Victoria and New South Wales. Unconfirmed outbreaks have also been reported from Western Australia.

NePlus and Fritz are susceptible cultivars with both young and established trees being affected. The losses attributed to this disease have ranged from minimal to severe. Yield reductions through nut gumming or premature nut fall cause the major economic losses. The longer term effects of defoliation and twig dieback on almond tree vigour and economic life have not been determined.

Management requires a combination of strategic chemical applications, cultural modifications and 'best practices' orchard hygiene.

OTHER HOSTS

Stone fruit, including plums, apricots and nectarines are susceptible to Bacterial Spot. As with almonds, some cultivars are highly susceptible while others exhibit tolerance. This bacterium is endemic in northern New South Wales and Queensland and Bacterial Spot is increasingly difficult to manage in these areas which frequently experience spring and summer rains and humidity.

SYMPTOM DESCRIPTIONS

Leaves

Circular, angular or irregularly-shaped reddish lesions on the leaf blades. They may be discrete or coalesced along the mid-veins or at the leaf margins. As the lesions dry out, shotholes and leaf blisters appear. These symptoms have been confused with those resulting from infection by the fungus Wilsonomyces carpephilus, the cause of fungal 'shot-hole'.

Nuts

Infected nuts develop corky lesions from which asae and gum exude. The exudate is clear to orange-red in color and hardens as it dries. Other lesions may be larger, sunken and covered in gum. Gummed nuts tend to be cleaved within the canopy. In some severely affected trees greater than 90 percent of nuts are gummed and premature nut drop results. In trees with fewer infected nuts, the gummed nuts remain attached to the tree after harvest, as stick-lights. These 'mummies' harbour viable bacteria and potentially serve as inoculum sources thereafter.

Twigs

Twig lesions have been observed in trees with extensive leaf and nut symptoms. The lesions are dark, slightly sunken and shiny. They extend along the length of the twigs. Twig dieback has been observed when the lesions have expanded sufficiently to girdle the small twigs. The observed twig lesions have developed on green wood. Cankers on older wood, as frequently develop on infected stone fruit, have not been observed on almonds.

Leaf and twig symptoms. Note circular, angular spots, holes and blisters on leaves and dark, shiny lesions on twigs.

Varietal Susceptibility

Extensive gumming of nuts, leaf blisters and shotholes have been observed on the pollinator cultivars Fritz and NePlus. While a small number of gummited nuts have been found on Carmel, this cultivar is considered to have some tolerance to Bacterial Spot. Price and Nonpareil appear to have a high degree of tolerance.

Entry and Infection

Bacteria require a wound or natural entry site to enter a plant. These sites may be microscopic. Sandblast and wind abrasion spots on leaves, leaf scars, frost or growth cracks, pruning wounds are all suitable entry sites.

Bacteria also require a moisture film in which to proliferate. The conditions conducive to these bacteria and diseases development are mild, wet periods. Heavy dew, fog, irrigation and rain during the growing season increase the potential for development.

Exposed orchards in windy areas, are particularly prone to the disease if wet conditions also prevail.

Control

This is a bacterial disease and cannot be controlled chemically.

An effective management program for bacterial spot should include:

• Cultural modifications
• Spray programs
• Orchard sanitation

• Cultural modifications

Avoid planting NePlus or Fritz
Ensure all planting material is “disease-free”
Avoid overhead irrigation
Avoid exposed and windy planting sites
Avoid tree injuries
Establish windbreaks
Practice good frost control
Pruning - open up dense canopies to improve air flow and reduce leaf wetness periods.

• Spray program

Protect injury sites and natural entry points
Avoid copper in stone fruit
Apply copper at leaf fall to protect leaf scars
Apply copper at pink bud and again if wet conditions persist*

*The addition of mancozeb to copper sprays in 1996/97 was effective, but requires more investigation re rates and timing. NOTE: copper has phytotoxic potential on almonds.

Dormant and spring time copper sprays.

Sprays with bactericides.
## Wood Canker Diseases of Almond:
D. Doll, P. Rolshausen, K. Baumgartner, R. Travadon, R. Duncan, T. Michailides

<table>
<thead>
<tr>
<th>Name of canker disease</th>
<th>Causal pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band canker *</td>
<td><em>Botryosphaeriaceae species</em></td>
</tr>
<tr>
<td>Ceratocystis canker</td>
<td><em>Ceratocystis fimbriata</em></td>
</tr>
<tr>
<td>Cytospora (Leucostoma) canker</td>
<td>*Leucostoma cincta</td>
</tr>
<tr>
<td>Eutypa canker *</td>
<td><em>Eutypa lata</em></td>
</tr>
<tr>
<td>Foamy canker *</td>
<td>*Zymomonas species?</td>
</tr>
<tr>
<td>Phomopsis canker</td>
<td><em>Phomopsis &amp; Diaporthe species</em></td>
</tr>
</tbody>
</table>

### Other canker diseases

<table>
<thead>
<tr>
<th>Phytophthora cankers *</th>
<th><em>Phytophthora species</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial canker *</td>
<td>*Pseudomonas syringae pv. syringae</td>
</tr>
</tbody>
</table>
Band canker

- Primary infections
  - Current year’s band
  - Last year’s band
  - Trunk
  - Main scaffold
Secondary infections through pruning wounds
 ✓ Canker in wind cracks
Cankers of almond trees in a Livingston orchard (#1)

Number of trees affected

- **Primary**: 3
- **Secondary**: 14
- **Wind Cracks**: 6

Legend:
- **Carmel**
- **NP**
Botryosphaeriaceae on almond in California:

1. *Botryosphaeria dothidea*
2. *Neofusicoccum parvum*
3. *Neofusicoccum mediterraneum*
4. *Neofusicoccum nonquaesitum*
5. *Diplodia seriata*
6. *Macrophomina phaseolina*
7. *Dothiorella sarmentorum*

*Eutypa lata* (2012-13)

(* also on pistachio & walnut*)
Susceptibility of almond cultivars inoculated with *Neofusicoccum nonquesitum*
Isolated:
A Zynomonas sp. (bacterium) & a yeast
### Conclusions

1. Surveys show that cankers sometimes can reach high levels.

2. Cankers develop in growth cracks, pruning wounds, and wind cracks (1\textsuperscript{st} - 3\textsuperscript{rd} leaf trees) and pruning wounds mainly (4\textsuperscript{th} leaf & older trees).

3. Eight species of Botryosphaeriaceae are associated with cankers plus *Eutypa lata* (another canker fungus).

4. Almond cultivars show differences in susceptibility but none is resistant to canker diseases.

5. Management of canker diseases is critical when trees are young; limit big cuts and time pruning during dry weather.
Biocontrol of Aflatoxin:

Definition:
Aflatoxins are secondary, toxic metabolites of certain fungal species that contaminate some agricultural commodities

Incidence of aflatoxin contamination in California almonds
1 in 25,000 to 35,000 nuts
Molds that can produce aflatoxin in almonds in California

*Aspergillus flavus*  *Aspergillus parasiticus*
Aspergillus flavus

S strain
(almost all toxigenic)

L strain
(about 50% atoxigenic)
Selected one L strain, the AF36

Incidence of AF36, 4.6%

**Rationale:** Use the AF36 to displace the toxigenic *A. flavus* and *A. parasiticus* in orchards
The strain AF36 is widespread

<table>
<thead>
<tr>
<th>County</th>
<th>Almond</th>
<th>Pistachio</th>
<th>Fig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butte</td>
<td>6.5</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Colusa</td>
<td>3.0</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Fresno</td>
<td>…</td>
<td>3.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Glenn</td>
<td>4.4</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Kern</td>
<td>8.5</td>
<td>12.7</td>
<td>…</td>
</tr>
<tr>
<td>Madera</td>
<td>5.0</td>
<td>7.2</td>
<td>7.2</td>
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<tr>
<td>Merced</td>
<td>…</td>
<td>15.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Tulare</td>
<td>…</td>
<td>2.9</td>
<td>…</td>
</tr>
</tbody>
</table>

All the other atoxigenic strains < 1%
Irrigation is needed for spore production

As applied

Atoxigenic strain, AF36

Sporulation

After growth of AF36
Application rate: 10 lbs. per acre
Library samples for aflatoxin analysis – brought to Kearney

Samples taken at processing plant as nuts are being unloaded.
Reduction in aflatoxin-contaminated pistachio samples: (all harvests)
Aspergillus flavus AF36

COTTON: FOR USE ONLY IN THE STATES OF ARIZONA, TEXAS AND CALIFORNIA (Imperial, Riverside and San Bernardino counties only)

CORN: FOR USE ONLY IN THE STATES OF ARIZONA AND TEXAS

PISTACHIO: FOR USE ONLY IN THE STATES OF CALIFORNIA, ARIZONA, TEXAS AND NEW MEXICO

Aspergillus flavus AF36 is a strain of Aspergillus flavus that occurs naturally. When applied to cotton just prior to first bloom, to corn from the 7 leaf stage (V7) until silking, or to pistachio from late May through early July, Aspergillus flavus AF36 competes with strains of Aspergillus flavus that produce large amounts of aflatoxin and, in doing so, limits the amount of these high aflatoxin producers that become associated with the crop.

Active ingredient: Aspergillus flavus strain AF36

Other ingredients: Wheat seeds (sterilized, colonized)

Total: 0.0008% 99.9992% 100.0000%

* Contains a minimum of 3,000 CFU/gram in the End-Use Product

KEEP OUT OF REACH OF CHILDREN

CAUTION

First Aid

If swallowed: Do not induce vomiting. Call 911 or a physician. If person is not breathing, call 911 or an ambulance, then give artificial respiration, if possible. Call a poison control center or doctor for further information.

If inhaled: Remove from exposure area, into plenty of fresh air. Call a physician.

IF INHALED:
Almond experimental orchard

Percentage of *A. flavus* isolates from soil belonging to AF36
Percentage of toxigenic *Aspergillus flavus/A. parasiticus* isolates in the experimental almond orchard after application of AF36
Conclusions from the AF36 study in an exp. almond orchard

✓ The atoxigenic strain AF36 became the dominant strain in the soil where the AF36 product was applied.

✓ The atoxigenic strain AF36 persisted well in the soil for 2 years.

✓ No increase in nut decay.

✓ The *sorghum*-AF36 product shows promise as an alternative to the *wheat*-AF36 product.

The registration of AF36 in almonds is along the way!
Acknowledgments

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- Spencer Walse

Thank you
Almond Flower, Foliar, and Fruit Disease Management

Dr. J. E. Adaskaveg

Department of Plant Pathology and Microbiology

UC Riverside
Today’s almond horticultural practices have changed to increase production

<table>
<thead>
<tr>
<th>Changing practice</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-density planting</td>
<td>Less air circulation, increase in shading and orchard humidity</td>
</tr>
<tr>
<td>Higher nitrogen fertilization</td>
<td>Rapid growth, plant tissues more susceptible</td>
</tr>
<tr>
<td>Increase in irrigation duration</td>
<td>Increase in orchard humidity</td>
</tr>
<tr>
<td>Planting in areas less suitable for almond production</td>
<td>Environments may be more favorable for disease. Increased stress on trees.</td>
</tr>
</tbody>
</table>

Conditions that weaken trees and favor plant pathogens
The Disease Triangle of Plant Pathology

- **Host**: Physiology, growth pattern, disease susceptibility
- **Environment**: Climatic and micro-climatic conditions.
- **Pathogen**: Biology, ecology

Interactions between the components effect the amount of disease.
Almond diseases that have increased with changes in production

Scab – *Fusicladium (Cladosporium) carpophilum*
Alternaria leaf spot – *Alternaria* spp.
Hull rot – *Rhizopus stolonifer, Monilinia fructicola*
Management of Scab: Cultural Practices

- **Planting: Varietal Susceptibility**
  - **Most Susceptible**: Carmel, Merced, NePlus Ultra, Peerless, Price, Ruby, Sonora, Winters.
  - **Least Susceptible**: Nonpareil

<table>
<thead>
<tr>
<th>Practice</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting Design</td>
<td>Allow air circulation</td>
</tr>
<tr>
<td>Tree Pruning</td>
<td>Increase air movement and reduce RH</td>
</tr>
<tr>
<td>Irrigation Management</td>
<td>Reduce orchard RH</td>
</tr>
<tr>
<td>Clean Cultivation</td>
<td>Reduce orchard RH</td>
</tr>
<tr>
<td>Avoid heavy late-summer/fall fertilization with N</td>
<td>Reduce production of highly susceptible host tissues</td>
</tr>
</tbody>
</table>
Management of Scab with Fungicides

Dormant and in-season (after petal fall) treatments

Disease epidemiology determines most effective timings of fungicide applications
Fungicides for Managing Almond Diseases

**Inorganics**
- Copper, Sulfur
  - M1&2
  - 1960s

**Dithiocarbamates**
- Ziram, Manzate, Dithane
  - M3
  - 1940s

**Phthalimides**
- Captan
  - M4
  - 1950s

**Isophthalonitriles**
- Bravo, Echo, Equus
  - M5
  - 1960s

**Guanidines**
- Syllit
  - U12
  - 1960s

**Benzimidazoles**
- Topsin-M, T-Methyl
  - 1970s

**Dicarboximides**
- Rovral, Iprodione, Nevada, Meteor
  - M
  - 1980s

**Sterol inhibitors (DMIs)**
- Rally, Indar, Tilt, Bumper, Quash, Inspire, Tebuzol
  - 1970s - 1980s

**Dicarboximides**
- Phthalimides
  - SDHIs
  - Xemium, Luna Privilege, Fontelis
  - 1960s

**Anilinopyrimidines**
- Vangard, Scala
  - 1990s

**Qols**
- Abound, Gem, Headline, picoxystrobin
  - 1990s

**Hydroxyanilides**
- Elevate
  - 1990s

**Polyoxins**
- Ph-D
  - 1960s

**Pre-mixtures**
- Inspire Super
  - 3+9
  - 3+11
  - 7+11
  - Best activity against scab

**Best activity against scab**
- Multi-site mode of action
- Single-site mode of action
- Reduced risk fungicides
- FRAC group
Management of Scab: Dormant applications to reduce inoculum in the spring

### 2013

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Oil</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kocide 3000 5 lb</td>
<td>+</td>
<td>Jan. 2013</td>
</tr>
<tr>
<td>Bravo WeatherStick 4 pts</td>
<td>+</td>
<td>Jan. 2013</td>
</tr>
<tr>
<td>Bravo WeatherStick 6 pts</td>
<td>+</td>
<td>Jan. 2013</td>
</tr>
</tbody>
</table>

**Incidence of twig sporulation (%)**

- **April 18**
  - a
  - b
  - c

- **May 22**
  - a
  - b

**Comparison of copper-oil and chlorothalonil-oil:**
*Extended prevention of twig sporulation into early summer with chlorothalonil-oil.*
**Dormant treatments to reduce scab inoculum in the spring**

- Bravo WeatherStik received a Section 2(ee) registration for dormant application between Dec. 1 and Jan. 10 (before bud swell)
- Higher rates and oil improved performance
- Full registration is planned through IR-4 to change PHI to 60 days and rate to 6 pts/A.
- Additional benefit: Align scab with Alternaria treatments

---

### Disease Dormant Pink bud Full bloom Petal fall Two week Five week May June

<table>
<thead>
<tr>
<th>Disease</th>
<th>Dormant</th>
<th>Bloom</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scab</td>
<td>++</td>
<td>-</td>
<td>+++</td>
<td>+/-</td>
</tr>
<tr>
<td>Dormant Chlorothalonil+oil</td>
<td>++</td>
<td>-</td>
<td>+++</td>
<td>+/-</td>
</tr>
<tr>
<td>Alternaria</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>
Management of Scab
In-season applications after start of twig sporulation

cv. Monterey
Colusa Co., 2013

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (l/A)</th>
<th>4/23</th>
<th>5/15</th>
<th>Incidence (%)</th>
<th>Severity rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Ph-D 11.3DF + NuFilm P</td>
<td>6 oz</td>
<td>@</td>
<td>@</td>
<td>bc</td>
<td>bc</td>
</tr>
<tr>
<td>Syllit 65WG</td>
<td>2 lb</td>
<td>@</td>
<td>@</td>
<td>bcd</td>
<td>bcd</td>
</tr>
<tr>
<td>Syllit + Tebuconazole&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2 lb + 6 oz</td>
<td>@</td>
<td>@</td>
<td>e</td>
<td>e</td>
</tr>
<tr>
<td>Syllit + Tebuconazole&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.5 lb + 6 oz</td>
<td>@</td>
<td>@</td>
<td>e</td>
<td>e</td>
</tr>
<tr>
<td>Luna Experience</td>
<td>6 fl oz</td>
<td>@</td>
<td>@</td>
<td>e</td>
<td>e</td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>5 fl oz</td>
<td>@</td>
<td>@</td>
<td>cde</td>
<td>cde</td>
</tr>
<tr>
<td>Merivon</td>
<td>5 fl oz</td>
<td>@</td>
<td>@</td>
<td>e</td>
<td>e</td>
</tr>
</tbody>
</table>

<sup>a</sup> Significance levels for treatment effects.
Management of Scab - Summary

- At locations with high disease levels, a dormant application should be done.
- An effective 3-spray program includes dormant and two applications after twig infection sporulation.
- Multi-site fungicides with low resistance potential (chlorothalonil, possibly mancozeb, captan, ziram) should be in rotations with the newer single-site and pre-mix fungicides.
- Syllit is a new scab material and should be used at 32 oz/A.
- **Single-site fungicides should not be applied once disease is developing.**
Management of Alternaria Leaf Spot – Field Efficacy trials

Alternaria alternata, A. arborescens, A. tenuissima

Ph-D, Luna Sensation, Quadris Top, Merivon

Control
cv. Monterey, Kern Co.
Management of Alternaria Leaf Spot – Field Efficacy trials 2013

cv. Monterey, Colusa Co.

Disease incidence and severity on leaves and defoliation reduced by all treatments.
Management of Alternaria leaf spot - Summary

• Late-spring/early-summer applications (based on the DSV model).

• Newer materials (e.g., Quash, Inspire Super, Ph-D, Quadris Top, Luna Sensation, and Luna Experience) have to be strictly used in rotations and mixtures for resistance management.

• Other components of an integrated approach in disease management are highly critical for management of Alternaria leaf spot.
Almond Hull Rot Control

- Caused by *Rhizopus stolonifer* or by *Monilinia fructicola*
- Both pathogens infect fruit and cause dieback

*Rhizopus stolonifer*  
*Monilinia fructicola*

- Inoculum of *Rhizopus stolonifer* is omnipresent (soil)
- Inoculum of *Monilinia fructicola* originates from other stone fruits (peaches, cherries) or almond. Blossom blight can be caused by *M. laxa* (North) and *M. fructicola* (South regions).
Hull rot caused by *M. fructicola* or by both pathogens is best managed by late-spring applications.
Hull rot caused by *M. fructicola* or by both pathogens is best managed by late-spring applications.
Knowledge on the management of hull rot is accumulating.

Fungicide treatments can be effective in reducing hull rot caused by *R. stolonifer* and by *M. fructicola*.

- For *Rhizopus* hull rot, early hull split applications when susceptibility is high should be done. Fungicides are applied most effectively with NOW applications.
- For *Monilinia* hull rot, applications should be done earlier (late spring).

For the most effective integrated management of hull rot, hull split should be induced simultaneously with proper water management (i.e., deficit irrigation).
New challenges – Bacterial spot of almond

• Causal agent: *Xanthomonas arboricola* pv. *pruni*
• Was found in spring 2013 on almond, cherry, and possibly other stone fruit crops. On almond, Colusa, San Joaquin, Stanislaus, Merced and Madera Co.

• Little is known about the disease:
  • Bacterial spot of peach (eastern US) occurs during high moisture conditions.
  • Fritz is one of most susceptible varieties, but isolations have also been made from Nonpareil, Butte, Carmel, and Price.
  • Management strategies are being explored: dormant and springtime applications with bactericides.
Thank you

UCCE Farm Advisors, Grower Cooperators, Industry Reps, and PCAs