Pest Management Update

Bob Curtis, ABC (Moderator)
David Haviland, UCCE, Kern County
Kris Tollerup, UCCE IPM Advisor
Emily Symmes, UCCE IPM Advisor
Brad Hanson, UC Davis
Jim Adaskaveg, UC Riverside
Pest Management Update and Sampling: Insects, Weeds and Diseases
Integrated Pest Management in Almonds

• Information is readily available
  – UC Statewide IPM program, Farm Advisors, Almond Board

• The toolbox has never been so full
  – Sampling methods
  – Pheromone traps
  – Economic injury levels
  – Cultural controls
  – Biological controls

• When insecticides are needed
  – Numerous insecticides representing many modes of action
  – Multiple options available for nearly all situations
  – Mating disruption
Pesticide Use Trends - Insecticides

- Increasing annually due to increased acreage
- Increasing annually on a per acre basis
- Cotton is no longer king… almonds are
  - This puts a target on the back of the industry
- Pesticide use needs to be based on sampling and thresholds when other control options are exhausted
Chlorpyrifos Use in Almonds

• Functionally it is the last broad spectrum insecticide available to almond growers that is not an pyrethroid

• Off-site movement is a concern
  – Dormant treatments and water
  – Found in regional monitoring efforts
  – High emitter of VOCs

• DPR under pressure to restrict use

• Critical Uses Plan was developed (ABC/University/DPR)
  – Collaborative effort by ABC, Univ. of California, and CDPR
  – Goal of identifying prudent uses
  – Goal to maintain availability

• Chlorpyrifos now a restricted material
  – Has to be on permit, requires PCA recommendation, requires NOI

• Proposed air quality regulations
  – Low-VOC formulation required after May 1
Leaffooted bug update

• WARNING: Leaffooted bug populations in the southern San Joaquin Valley are at all-time highs
  – LFB completed an extra generation this year
  – Populations are comparable or higher than fall 2005

• Appropriate winter response
  – If you find an aggregation, don’t kill it. Monitor it
  – Watch weather. A good freeze could solve all potential problems
  – A mild winter could lead to a repeat of 2006

• Spring treatments should be based on monitoring (avoid overreacting)
  – Primary concern is March to May
  – Bugs in trees- pole sampling
  – Gummosis on nuts
  – Nut drop
Insecticides for leaffooted bug

• Lorsban- industry standard
  – Excellent on contact, residual of 1 week
• Pyrethroids- Brigade and Warrior II
  – Excellent on contact, residual of 4+ weeks
• Abamectin- Agri-mek and others
  – Excellent on contact, no residual activity
• Belay, Bexar, Sivanto, Beleaf, Exirel, Sequoia
  – Some contact activity, no residual activity
Proposed air quality regulations

Pesticides make up about 6% of VOC emissions
• Biggest almond contributions are Brigade, Agri-Mek, Fujimite, Lorsban, Onager, Goal

Use restrictions apply to:
• High-VOC products containing abamectin, chlorpyrifos, gibberellins, or oxyfluorfen
• SJV between May 1 and October 31
• To alfalfa, almonds, citrus, cotton, grapes, pistachios, or walnuts.

Almond grower adaptation to new regulations
• Switch to low-VOC abamectin and chlorpyrifos
  – Agri-Mek SC and Lorsban Advanced are excellent
• Voluntarily minimize use of high-VOC bifenthrin, fenpyroximate, hexythiazox
  – efficacy of low-VOC formulations debatable
Navel orangeworm trapping and management

- Options improving each year
- Mating disruption more practical
- Egg traps still available
- Pheromone trap knowledge increases annually

Reasons for trapping
- Improved application timing
- Treatment thresholds
- Evaluate insecticide efficacy
- Confirm trap shutdown in Mating Disruption blocks
- Determine moth sources (internal or external)
- Compare pest density across seasons
NOW traps

- 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\textsuperscript{nd}/3\textsuperscript{rd} flights
  - Creative uses
    - Residual effects of insecticides that kill adults
    - Document shut-down in mating disruption orchards

Source: Brad Higbee, Paramount Farming Company
B. Higbee, Paramount Farming Co.

RF = Resistance factor = LC$_{50}$ of field strain/LC$_{50}$ 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)

### 48 hr mortality tables

<table>
<thead>
<tr>
<th>Year</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Year</th>
<th>Male</th>
<th>Female</th>
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<th>Female</th>
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<td>0.8</td>
<td>2009</td>
<td>0.3</td>
<td>0.5</td>
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<td>0.8</td>
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<tr>
<td>2010</td>
<td>2.1</td>
<td>2.1</td>
<td>2</td>
<td>2</td>
<td>2010</td>
<td>1.35</td>
<td>1.8</td>
<td>1.3</td>
<td>1.65</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>1.1</td>
<td>0.7</td>
<td>0.75</td>
<td>2011</td>
<td>1.7</td>
<td>2.1</td>
<td>1.2</td>
<td>1.5</td>
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<td>2012</td>
<td>2.4</td>
<td>2.5</td>
<td>3.1</td>
<td>3.8</td>
</tr>
<tr>
<td>2013</td>
<td>5.4/5.3</td>
<td>6.6/6.1</td>
<td>4.0/3.9</td>
<td>4.8/4.5</td>
<td>2013</td>
<td>7.9</td>
<td>8.8</td>
<td>5.8</td>
<td>6.5</td>
</tr>
<tr>
<td>2014</td>
<td>6.3/7.2</td>
<td>6.4/7.9</td>
<td>6.4/7.3</td>
<td>7.8/9.6</td>
<td>2014</td>
<td>10.6-13.8</td>
<td>10-13.9</td>
<td>10.8-14</td>
<td>12.1-17</td>
</tr>
</tbody>
</table>

RF = Resistance factor = LC$_{50}$ of field strain/LC$_{50}$ of USDA strain
Monitoring for spider mites

• Tolerate low mite population early in the season
• Biological control organisms get established
• Monitor mite densities (presence/absence on leaves)
• If less than 1/3 of leaves are infested, do not treat, mites will increase slowly and biocontrol can keep up
• If more than 1/3 of leaves are infested, 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
Southern SJV experience of PCAs using monitoring and thresholds

- Spring 2013- Lots of mites and few beneficial organisms suggested that an aggressive approach to mite management was needed to prevent defoliation. Multiple miticide applications were made

- Summer 2013- Lack of mites and presence of beneficials led many growers to skip mite sprays at hull split

- Late winter 2014- Many growers concerned about mites again in 2014, especially due to dry winter, early heat, and tree stress from lack of irrigation

- Spring 2014- Monitoring showed elevated biological control, no need to treat

- Summer 2014- PCAs using monitoring and thresholds averaged one miticide application for the season
Pollinator safety

- Almond growers rely on bees for production
- Protection of bees during bloom has always been a priority of almond growers
- Pesticide labels include specific guidelines related to bee safety and must be followed
- On rare occasions, insecticides used legally at bloom in combination with fungicides have resulted in reduced brood health
- The ABC and Univ. of CA have revised PTB guidelines to recommend that management, if needed, be done in the dormant season or during ‘May sprays’
Kris Tollerup
UCCE IPM Advisor
Sampling: The “How” for Navel Orangeworm and Leaffooted Bug

Kris Tollerup, University of California Cooperative Extension Advisor, IPM, Kearney Agricultural Research and Extension Center
Sampling: The How for Navel Orangeworm

• Egg traps constructed from modified 50-dram vial filled 50% with almond meal plus 10% wt/wt crude almond oil. HOWEVER, food-grade almond meal works well.
  – Begin 1\textsuperscript{st} week of April.
  – One trap / 10 acres or minimum of 4 / orchard.
    • Divide large acreage into sprayable blocks.
  – Hang traps at head-height
    • North side of tree (non-Pareil) & 1 to 3 ft inside canopy.
    • Avoid water hazard.
  – Check 2x / week until biofix
    • First of two consecutive dates on which eggs increase on 75% of traps.
Sampling: The How for Navel Orangeworm

- Continue monitoring traps, remove eggs as you continue.
- Replace bait each 4 weeks.
- Eggs are flat, laid primarily on ridges of trap
  - Eggs white when first laid then turn orange-red prior to hatching.
- Graph egg numbers on monitoring form provided by UC Pest Guidelines
  (http://www.ipm.ucanr.edu/PMG/C003/almond-ornegwrmeggtrtap.pdf.)
  - Biofix: Begin accumulation of degree-days.
  - Data provides information when new generation begins egg-laying.
  - Use data to verify degree-day calculation.
Sampling: The How for Navel Orangeworm

- Pheromone traps: Delta or white wing sticky trap baited with female synthetic sex pheromone.
- Hang in orchard mid-March
  - Use in conjunction with egg traps.
- Hang in tree at approximately head height.
- Count moths at least once per week.
- Change lure ~ 4 to 6 weeks.
- Change sticky card when “saturated”.
- Careful not to confuse meal moth for NOW.
- **Understanding of male NOW capture in progress**
Sampling: The How for Leaffooted Bug
Sampling: The How for Leaffooted Bug

• Beat trays
  – Easy to detect species in canopy.
  – Immediate information.

• Poles
  – 8-ft pole used to strike upper limbs
    • Count the number of LFB which fly.

• Damaged nuts, in tree and on ground
  – Indicates presences of LFB.
  – Can estimate percentage of damage nuts.
  – Confirm damage by cutting across damage area.

• Critical period to sample
  – March and April.

• Overwintering aggregations.
Sampling: The How for Leaffooted Bug

• Limiting issues
  – No economic injury level.
    • Small population can cause substantial damage.
  – Pheromone not yet understood.
  – LFB part of large-bug complex.
    • Species change over the season.
    • Shell hardness differs; affects damage.
  – LFB is long-lived with 3 and a partial 4\textsuperscript{th} generation per season.

• Work to improve sampling is in progress.
Sampling: The How for Spider Mites

- Sequential binomial sampling plan
  - Weekly, May through August.
  - Prior to July, focus on hot-spots.
  - Minimum of 5 trees/sampling area, 15 leaves/tree.
  - Examine leaves for spider mite adults, eggs, and natural enemies.
  - Note number of leaves with mites/eggs and with natural enemies.
  - Post 1 July, monitor whole orchard
    - Separate orchard into units that can be sprayed separately.
## Sampling: The How for Spider Mites

<table>
<thead>
<tr>
<th>Tree number</th>
<th>Total leaves sampled</th>
<th>No. leaves W/mites/tree</th>
<th>Cumulative no. leaves W/mites</th>
<th>No. leaves w/predatory mites/six spotted thrips</th>
<th>Predators absent</th>
<th>predators present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td></td>
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<tr>
<td>3</td>
<td>45</td>
<td>5</td>
<td>12</td>
<td>0</td>
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<tr>
<td>4</td>
<td>60</td>
<td>5</td>
<td>17</td>
<td>0</td>
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<td>5</td>
<td>75</td>
<td>11</td>
<td>28</td>
<td>0</td>
<td>≤27</td>
<td>≥40</td>
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<td>6</td>
<td>90</td>
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<td>≥48</td>
</tr>
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<td>7</td>
<td>105</td>
<td>7</td>
<td>45</td>
<td>0</td>
<td>≤39</td>
<td>≥55</td>
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<td>120</td>
<td>12</td>
<td>57</td>
<td>0</td>
<td>≤45</td>
<td>≥62</td>
</tr>
<tr>
<td>9</td>
<td>135</td>
<td>11</td>
<td>68</td>
<td>0</td>
<td>≤51</td>
<td>≥69</td>
</tr>
<tr>
<td>10</td>
<td>150</td>
<td>15</td>
<td>83</td>
<td>0</td>
<td>≤57</td>
<td>≥76</td>
</tr>
</tbody>
</table>

Don't treat (if total leaves w/mites is), Treat (if total leaves w/mites is)
Emily Symmes
UCCE IPM Advisor
Pest Management Update & Sampling:
Peach Twig Borer and San Jose Scale

Emily J. Symmes, PhD
Area IPM Advisor, Sacramento Valley
University of California Cooperative Extension
University of California Statewide IPM Program
Peach Twig Borer

Treatment Options:

- Dormant treatment
- Bloom Bt treatment
- Spring treatment
PTB Bloom Monitoring – Hibernacula

• Weekly beginning at popcorn stage
• Examine 10 hibernacula per orchard
  – Limb crotches or bark cracks, especially 2-3 year old wood
  – Cut small wedges of bark around hibernacula
  – Pinch bark to open hibernacula looking for presence of larva
• Bt treatments for moderate to high PTB populations
  – 20-40% larval emergence
  – 7-10 days later or 80-100% larval emergence
  – Third possible at 80-100% if emergence is spread out
PTB Spring Monitoring – Shoot Strikes

- Weekly beginning mid April
- Walk through orchard and cut down any shoot strikes
- Slice into shoot strikes to determine PTB or OFM
- Threshold
  - 4 or more shoot strikes per tree in mature orchard
PTB – Spring Monitoring for Treatment Timing

• Pheromone traps
• Hang by March 20 (south) and April 1 (north)
• 1 trap/20 acres, minimum 2/orchard
  – Uniform
  – Additional traps in hot spots
  – Shade
  – 6-8 ft high
  – 1-3 ft inside canopy
  – North tree quadrant
  – Minimum 5 trees from edge
• Check 2x/week until biofix
  – First date moths are consistently caught
• If shoot strike monitoring indicates treatment, begin accumulating DD and treat accordingly depending on material
PTB – Harvest Samples

- Establish orchard history to help inform treatment decisions
- Check efficacy of management program
- Collect & crack out 500 nuts per block
- Identify pest infestation
## PTB – Harvest Samples

<table>
<thead>
<tr>
<th></th>
<th>PTB</th>
<th>OFM</th>
<th>NOW</th>
<th>ANT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kernel</strong></td>
<td>Shallow channels &amp; surface groove on kernels</td>
<td>Shallow channels &amp; surface groove on kernels</td>
<td>Deep chewing in nut</td>
<td>Scraping or peeling of kernel skin, deep hollowing of nut, “sawdust” present</td>
</tr>
<tr>
<td><strong>Frass</strong></td>
<td>None</td>
<td>Reddish brown; very little</td>
<td>White; often a lot</td>
<td>No</td>
</tr>
<tr>
<td><strong>Webbing</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Boring</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Hollowing</td>
</tr>
</tbody>
</table>
San Jose Scale – Dormant Spur Sampling

- 1X/year
- 35-50 trees (random) per orchard or plot
- 100 spurs total
  - 2-3 spurs (random) from inside of each tree canopy near main scaffold
- Clip spur off at base
  - Include old spur wood along with past season’s growth
- Sequential sample
- Examine 20 spurs at a time
  - Count live SJS
  - Note level of parasitization

Parasitized SJS

SJS black cap stage
# SJS – Dormant Spur Sampling Thresholds

<table>
<thead>
<tr>
<th># of Spurs</th>
<th># of SJS infested spurs (not parasitized)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0: Stop sampling – no treatment necessary</td>
</tr>
<tr>
<td></td>
<td>1-3: Examine 20 more spurs</td>
</tr>
<tr>
<td></td>
<td>≥ 4: Stop sampling – treatment recommended</td>
</tr>
<tr>
<td>40</td>
<td>1: Stop sampling – no treatment necessary</td>
</tr>
<tr>
<td></td>
<td>2-5: Examine 20 more spurs</td>
</tr>
<tr>
<td></td>
<td>≥ 6: Stop sampling – treatment recommended</td>
</tr>
<tr>
<td>60</td>
<td>≤ 3: Stop sampling – no treatment necessary</td>
</tr>
<tr>
<td></td>
<td>4-7: Examine 20 more spurs</td>
</tr>
<tr>
<td></td>
<td>≥ 8: Stop sampling – treatment recommended</td>
</tr>
<tr>
<td>80</td>
<td>≤ 5: Stop sampling – no treatment necessary</td>
</tr>
<tr>
<td></td>
<td>6-8: Examine 20 more spurs</td>
</tr>
<tr>
<td></td>
<td>≥ 9: Stop sampling – treatment recommended</td>
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<tr>
<td>100</td>
<td>&lt; 10: No treatment necessary</td>
</tr>
<tr>
<td></td>
<td>≥ 10: Treatment recommended</td>
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</table>
**SJS – Dormant Spur Sampling Form**

Almonds – Dormant Spur Sampling

**Supplement to UC IPM Pest Management Guidelines: Example Form**

**Directions:**
1. To monitor for San Jose scale (SJS), European fruit leaffolder (EFL), and mites, clip off 2 to 3 spurs randomly from each of 35 to 50 trees in the orchard, for a total of 100 spurs.
2. Using a hand lens or microscope, examine spurs for scales and mite eggs.
3. On the form below, note presence or absence of each pest on each spur for the first 20 spurs. Add up totals after every 20 spurs (including previous samples) and compare to treatment decision guidelines below. Continue as needed using page 3.

<table>
<thead>
<tr>
<th>Grower/Orchard</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SJS number</th>
<th>Live SJS</th>
<th>Paralyzed SJS</th>
<th>EFL</th>
<th>Mite eggs</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
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</tbody>
</table>

**Treatment decision:**
- If grand total of all SJS or EFL-infested spurs is less than 9 but more than 5, look at another 20 spurs and record on chart to the right.
- If over 9, stop sampling and treat.
- If less than 5, stop sampling.
- Treated for mites if 50% or more spurs are infected.

**Treatment decisions:**
- If grand total of all SJS or EFL-infested spurs is less than 9 but more than 5, look at another 20 spurs and record on the chart to the right.
- If over 9, stop sampling and treat.
- If less than 5, stop sampling.
- Treated for mites if 50% or more spurs are infected.

(Rev. 23 March 2009) Print copies of this form at www.ipm.ucdavis.edu/FORMS/
SJS – Spring Monitoring for Treatment Timing

- Pheromone traps
  - Detect male emergence
  - Detect presence of parasitoids
- 3-4 traps/block
- Hang by February 25 (south) & March 15 (north)
  - Uniform
  - Additional traps in hot spots
  - Shade
  - 6-7 ft high
  - North or east tree quadrant
  - Minimum 5 trees from edge
- Check 2X/week until biofix
  - First date males are consistently caught
- If spur samples indicated treatment, begin accumulating DD and treat accordingly depending on material
SJS – Spring Monitoring for Treatment Timing

- Sticky tape
  - Monitor crawler emergence to time treatments if warranted
- Wrap clear plastic tape around scaffold limbs
- If spur samples indicated treatment, begin accumulating DD and treat accordingly depending on material
Thank you & Questions?
Brad Hanson, UC Davis
Pest Management Update - Weeds

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

- Brad Hanson – Weed Extension Specialist
  - Chemical weed control, herbicide resistance, herbicide fate
- Lynn Sosnoskie - Project Scientist
  - Weed biology, ecology and resistance management
- Bahar Kutman – Postdoctoral Researcher
  - Glyphosate and micronutrient interactions
- Sarah Morran– Postdoctoral Researcher
  - Genetics and physiology of glyphosate resistance
- 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
- Caio Brunharo – PhD Student
  - Glyphosate and glufosinate resistance in ryegrass
- Mariano Galla – PhD Student
  - Herbicide drift injury on walnut and other crops
Weed challenges in T&V

• Old favorites:
  – Normal mix of annual grasses and broadleaves
  – Challenge with perennial weeds, especially in new orchards or crops with fewer herbicide options

• New weed problems
  – Most of the “new” issues seem to be related to glyphosate resistance and/or shifting populations to tolerant species

• Changing control options
  – Less tillage, some new herbicides, water quantity-quality-delivery issues
## Confirmed glyphosate resistance

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### Current T&V herbicide registration status

#### Herbicide Registration on California Tree and Vine Crops - (updated February 2014 - UC Weed Science)

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New glufosinate herbicides

- Glufosinate herbicides
  - Have been short in recent years, now off-patent

- Rely 280, Reckon 280, Glufosinate 280SL, Forfeit 280, Refer 280SL, Lifeline, (Cheetah – pending DPR)
  - Mostly same registrations as Rely 280 – minor exceptions due to differences between master/package label
    - Similar recommendations for adjuvants/surfactant
  - Group 10 herbicide. POST activity only. Broadleaf and grass activity. Small amount of translocation.

  - In our testing, performance has been similar among brands
  - Recall that glufosinate can injury young almond trees
Alion – major label changes

- Several key changes
  - Modified use pattern in tree nuts, grape, stonefruit, pomefruit, olive
    - Citrus label not changed
  - Do not use in flood-irrigated systems
  - Age changes: almond/walnut/pistachio (1yr), grape (5yr), pome/stone/olive (3yr), citrus (1yr)
  - Soil OM rate restriction
    - <1% - max rate 3.5 fl oz/A
    - 1-3% - rate 3.5 to 5 fl oz/A (5 oz max for grape if above 1%)
    - >3% - rate 5 to 6.5 fl oz/A
  - Avoid spring applications for best performance

- Will impact almond growers and PCAs
Important oxyfluorfen use change

• VOC regulations will affect use of Goal 2XL and similar herbicides in summer
  – Several high VOC pesticides have been under consideration for additional regulation during the summer (May-Oct) “ozone” season
  – The trigger was hit in 2014 so additional restrictions will be implemented
  – Max use rate of EC formulations of oxyfluorfen will be limited to 0.125 lb ai/A (1 pt of a 2lb product)
    • Does not affect rates Nov-April
    • Does not affect SC formulations (eg GoalTender)
  – Will impact almond growers and PCAs
In other T&V crops, may hear about:

• Sulfentrazone (Zeus)
  – Group 14 herbicide. PPO inhibitor
    • PRE and POST activity
  – Registered in early 2014 in CA
    • Grape, lemon, orange, pistachio, walnut (3 yrs or older)
  – Recommended rate 10-12 fl oz/A
  – Primarily broadleaf weed control, good suppression of nutsedge
    • Good efficacy on GR conyza in a Parlier trial
    • Suppression of nutsedge 6 MAT in an Atwater trial
  – Best as part of a integrated program

  – Not likely to be registered in almond or stonefruit any time soon
In other T&V crops, may hear about:

• Flazasulfuron (Mission)
  – Group 2 herbicide, ALS inhibitor

• CA registrations on grape (3 yrs), citrus (5 yrs)
  – PRE and POST activity
  – Rate range 2.14-2.85 oz/A. Needs NIS for POST
  – Activity on some grasses and some broadleaves. Good suppression of sedges and kyllinga

  – Not registered in CA almond, future prospects not known?
Table 4. Selected weed control evaluations from 2013-14 comparison of Alion and other preemergence tankmix partners in an almond orchard near Wasco, CA. All treatments included a high rate of Rely 280 and Roundup Powermax to ensure good control of existing weeds. (Watkins, Moretti, and Hanson)

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<th>61 DAT</th>
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LSD (P=0.05) 6 7 31 9 24 34 25

Table 6. Selected weed control evaluations from 2013-14 comparison of Alion and other preemergence tankmix and sequential partners in an almond orchard near Escalon, CA. All treatments included a high rate of Rely 280 and Roundup Powermax to ensure good control of existing weeds. (Watkins and Hanson)

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<th>Crabgrass</th>
<th>Sowthistle</th>
<th>Hairy fleabane</th>
<th>Spotted spurge</th>
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LSD (P=.05) 32 34 20 22 14 11 17 18

The 'A' timing was applied December 17, 2013 and the 'B' timing on March 19, 2014. All treatments at both timings included Roundup Powermax plus Rely 280 and AMS for control of emerged weeds.
Table 7. Preemergence weed control with Matrix and Alion combinations and sequential treatments in a walnut orchard trial conducted near Chico, CA in 2014. (Watkins and Hanson)

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<th>Overall</th>
<th>64 DAT-A</th>
<th>124 DAT-A</th>
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<th>Hairy fleabane</th>
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</table>

The 'A' timing was applied December 18, 2013 and the 'B' timing on March 20, 2014. The entire trial area was oversprayed with Roundup Powermax plus Rely 280 at the same time as the 'A' timing for control of emerged weeds.
A few random thoughts on almond weed management

- Think about your glyphosate formulations/rates – AI concentration and surfactant loads vary
- Consider PRE herbicide programs and mixes
- Consider sequential PRE applications to extend control into summer
- Think about weed control over several seasons - integrated weed management
Orchard Sampling Workshop – Weed Scouting Recap
Why orchard scouting matters for weed managers

- Basing control decisions on actual weed problems
  - Control the weeds you KNOW you have (or will have)

- Avoid ineffective treatments
  - Using the wrong tool for the job wastes time and money
  - Will likely have to be retreated or controlled some other way

- Avoid overtreatment
  - Wastes money and time
  - Puts a higher than necessary load of pesticide in the environment
  - Crop safety concerns?

- Identify new weed problems when they are small
  - New invasive species, resistant biotypes, etc.
  - Can use more intensive control strategies on the pockets that need it rather than field-wide
Spatial sampling

• Wide range of sampling intensities
  – Map illustrates a fairly intense grid sampling strategy
    • Probably a bit excessive in terms of precision needed
  – Could be a “drive by” observation from the truck or “ask the irrigator”
    • Probably a bit lax

• Take a walk or ride through each zone a few times each season
  – “zone” size may vary among operations due to scale

• Key points
  – Cross the top, middle, and bottom of the field to account for that variability
  – Don’t follow traffic patterns
  – Hit known “different” areas (soils, swales, historical use)
  – Note weed differences in middles vs rows

Modified from Koller and Lanini 2005 (Calif Agric 59:182)
• Key points:
  – Monitoring should begin after harvest.
    • Recall the techniques used last year and consider how they worked. Adjust as needed.
    • Scout orchards to assess weed presence and size for fall treatments with PRE/POST tankmixes
  – In late winter, assess the efficacy of the dormant season weed control program. Decide on spring program needs.
  – In late spring, evaluate previous control efficacy and determine pre-harvest weed control program.
  – At harvest, note how well the yearly program worked.
Orchard weed scouting

• Get a good representation of the weeds throughout the orchard management zone
• Scout several times per year to catch multiple weed flushes at sizes that can be controlled
• Choose the right tool for the job
  – Avoid economic and environmental problems with over- or under-treating
  – May need to consider rows and middles separately
• Keep records and compare year-over-year
  – Identify new weed problems and weed control failures and address at early stages
• Use scouting results to reevaluate and refine your weed management program
  – Should be an iterative process and something to consider throughout the year
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UC Davis Weed Research and Information Center
http://wric.ucdavis.edu/
http://ucanr.org/blogs/UCDWeedScience/
@UCWeedScience on Twitter
Jim Adaskaveg, UC Riverside
Disease Management Update and Optimum Fungicide Usage Based on Host Phenology and Disease Monitoring

Dr. J. E. Adaskaveg
Department of Plant Pathology
University of California, Riverside
Foliar and fruit diseases of almond in California

- Brown rot blossom blight
- Green fruit rot/Jacket rot
- Shot hole
- Bacterial spot
- Anthracnose
- Scab
- Alternaria leaf spot
- Rust
- Hull rot
Fungicides for Managing Almond Diseases

Inorganics and Conventional Synthetics

New:
Luna Products & Merivon (2014), Syllit (2014), Viathon (2015), & new products continue to be evaluated
Why disease monitoring and risk assessment?

• Determine pathogen population size
• Determine possibility of disease outbreaks or increases in disease intensity based on general weather forecasts
• Assess if, when, and where disease management has to be implemented
• Optimize disease management - effective and economical
Inoculum-based
- Inoculum (disease) levels in the current and previous seasons are indicators for risk.
- Inoculum may not be present at high levels and disease progress can be monitored.
- Once inoculum is found, management practices can be implemented.
- Examples: shot hole, scab, rust, bacterial spot

Host phenology-based
- Disease occurs on specific host tissues during a limited time in the season
- Inoculum is commonly present
- Examples: blossom blight, Rhizopus hull rot

Microclimate-based
- Pathogen inoculum is commonly present.
- Climatic conditions determine disease progress.
- Examples: Alternaria, anthracnose, bacterial spot

Optimum timing for implementing management practices
- Temperature, wetness, wind
- Cultivar, phenology
- Presence of inoculum, mono- or polycyclic
- Interactions between the components effect the amount of disease.
Examples of diseases where management is based primarily on amount of pathogen inoculum

- Shot hole
- Scab
- Rust
If inoculum is present at critical levels in the previous season and at leaf emergence in the spring, climatic conditions determine disease progress.

**Shot hole of almond - Disease cycle in California**

**Winter**
- Infected leaves, twigs, and buds

**Spring**
- Primary inoculum
- Infection of leaves and blossoms

**Summer**
- Infection of leaves, twigs, fruit, and buds
- Production of secondary, tertiary, .... inoculum

**Fall**
- Infected leaves, twigs, and buds

*Wilsonomyces carpophilus*
Shot hole management program for almond

Risk assessment for next season

**Fall**

- Sporodochia absent: Low risk
  - Monitor for sporodochia
  - Apply fungicide

- Sporodochia present: High risk
  - Apply fungicide at leaf emergence
  - Monitor for sporodochia

**Spring**

- Sporodochia present
  - Apply fungicide
  - Monitor for sporodochia

- Sporodochia absent
  - Monitor for sporodochia

Monitor for sporodochia in the previous fall and in the spring of current season
Almond Rust Disease Cycle

Repeating stage: re-infection of new host tissue from secondary, tertiary, ..... inoculum.

Driven by environmental conditions and host susceptibility.
Management of almond rust with properly timed fungicides

- Biweekly monitoring is needed in the spring.
- Start applications with first detections of rust on leaves (angular yellow flecks) at 1% incidence and continue prior to forecasted rains.
- The goal is to shift the disease progress curve by 8-12 weeks.
- Fall defoliation before epidemics reduces overwintering inoculum.

Disease progress curves of rust without and with fungicide applications starting at first detection in the spring. With fungicide applications, the progress curve is shifted so that defoliation from disease occurs late in the season.
Management of almond rust with properly timed fungicides

- Start in-season treatments with multi-site material: mancozeb or chlorothalonil.
- Second and third applications: use single-site materials as premixtures: QoI (FRAC 11) SDHI (FRAC 7), and DMI (FRAC 3) compounds. Sulfur and chlorothalonil are also effective. Dormant treatments are ineffective.
- Azoxystrobin or propiconazole have post-infection activity (applied 1-2 days after rainfall) because they are locally systemic.
Disease cycle of almond scab and management strategies using dormant and after petal fall in-season treatments

Disease epidemiology determines most effective timings of fungicide applications.

**Fusicladium carpophilum**

Sporulation of overwintering twig lesion

Conidia (asexual stage) production in the spring and throughout season

Infection of twigs (<1 year old), fruit, and leaves

Survival on fallen leaves in winter

Development of sexual fruiting structures

Ascostroma with asci and ascospores

Ascus with ascospores

Sexual stage in California?

Dormant treatments

Petal fall treatments starting at twig sporulation

Defoliation and weakening of trees during severe outbreaks
Almond scab in California

- Scab has become a common disease at many locations in recent years and the disease has to be managed.

- Effective management requires
  - Knowledge of the disease history of the orchard
  - Application of dormant treatments to delay twig sporulation
  - Monitoring for twig sporulation in the spring
  - Fungicide application at the beginning of twig sporulation

Twig lesions non-sporulating (top) and sporulating (bottom)
Management of Scab: Dormant applications to reduce inoculum in the spring

- Chlorothalonil-oil is highly effective in delaying sporulation of twig lesions into late spring – copper-oil less effective, captan-oil or mancozeb-oil have little efficacy.
- Chlorothalonil is effective by itself, but oil increases effectiveness.
- Applications in mid-Dec. similarly effective as in mid-Jan.

### Table: cv. Carmel, Butte Co.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sporulation Incidence (%)</th>
<th>Rating (0-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>a</td>
</tr>
<tr>
<td>Manzate ProStick 6 lb + Oil 3.5 gal</td>
<td>ab</td>
<td>b</td>
</tr>
<tr>
<td>Captan 80WDG 5 lb + Oil 3.5 gal</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Bravo 6 pts + Oil 3.5 gal</td>
<td></td>
<td>c</td>
</tr>
</tbody>
</table>

 apresentada no gráfico. As figuras de controle não estão incluídas.
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, or before bud swell using the 4-pt rate.
- Full registration planned through IR-4 to change PHI to 60 days and rate to 6 pts/A.
- Benefits: Inoculum reduction, delay onset of epidemic, and synchronize scab with Alternaria treatments

<table>
<thead>
<tr>
<th>Treatment timing for scab and Alternaria</th>
<th>Disease</th>
<th>Dormant</th>
<th>Bloom</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment timing for scab and Alternaria</td>
<td>Scab</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>+++</td>
</tr>
<tr>
<td>Scab Dormant Chlorothalonil+oil</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
</tr>
<tr>
<td>Alternaria</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
</tr>
</tbody>
</table>
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.

**Most effective newer fungicides:**

**Single:** Quash, Ph-D, Syllit, EXP-1

**Pre-mixtures:** Quadris Top, Inspire Super, Luna Sensation, Merivon

**Rotations:** including Catamaran/Viathon.
Examples of diseases where management is based primarily on host phenology

Brown rot
blossom blight

Hull rot
Brown rot blossom blight

• Infection period is well defined – bloom period of 7 to 14 days for each variety in an orchard

• Risk of infection is determined by environmental conditions
  • Temperatures above 58F
  • Wetness

• Multiple highly effective fungicides are available
### Determining factors

<table>
<thead>
<tr>
<th>Delayed bloom application (30-40% bloom)</th>
<th>PB (5% bloom) and FB (80% bloom) applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental conditions (rain)</td>
<td>Highly favorable</td>
</tr>
<tr>
<td>Fungicide properties</td>
<td>With or without locally systemic action</td>
</tr>
</tbody>
</table>

- Many of the newer brown rot fungicides have some locally systemic activity and subsequently pre- and some post-infection activity.
- During less favorable environments a **single application at delayed bloom** (20-40% bloom) is sufficient for good disease control.
- During highly favorable conditions, a 2-spray program with applications at pink bud and full bloom is recommended.
Almond Hull Rot

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

- 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).
- The two pathogens require different management strategies
Numerous effective treatments available: FG 3, 7, 19, 3/7, 3/11, 7/11. Reduction of disease up to 70%.

Effective hull rot treatments are available

cv. Nonpareil, San Joaquin Co. 2014, Hull rot mainly caused by *R. stolonifer*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (/A) (oz/fl oz)</th>
<th>Applic. 6-5</th>
<th>Applic. 7-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Quash + S2200</td>
<td>3.36 + 3.36</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Luna Experience</td>
<td>8</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D + Tebucon*</td>
<td>6.2 + 8 + 8</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Inspire Super*</td>
<td>20 + 16</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Quadris Top*</td>
<td>14 + 16</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D + Quash*</td>
<td>6.2 + 3 + 8</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>5</td>
<td>@</td>
<td>@</td>
</tr>
</tbody>
</table>

* Added DyneAmic or NuFilm-P

Hull rot counts
Timing of hull rot treatments

Hull Rot caused mainly by *M. fructicola* 2012 trial

<table>
<thead>
<tr>
<th></th>
<th>4-4</th>
<th>4-25</th>
<th>6-6</th>
<th>7-13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td>---</td>
<td>@</td>
<td>@</td>
<td>---</td>
</tr>
<tr>
<td>Precip. 9.5 mm</td>
<td>@</td>
<td>@</td>
<td>@</td>
<td>---</td>
</tr>
</tbody>
</table>

Hull rot counts

Pathogen = *M. fructicola*: Pre-hull split applications (early/mid June)

Hull Rot caused mainly by *R. stolonifer* 2014 trial

<table>
<thead>
<tr>
<th></th>
<th>6/10</th>
<th>6/24</th>
<th>7/10</th>
<th>7/23</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>@</td>
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<td></td>
<td>---</td>
<td>@</td>
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<td>@</td>
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<tr>
<td></td>
<td>@</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
</tbody>
</table>

Hull rot counts

Pathogen = *R. stolonifer*: Early to late hull split applications but earlier applications at pre-hull split also help to manage the disease.

Both pathogens: Applications in early/mid June and at early hull split.
Examples of diseases where management is based primarily on environmental conditions

- **Alternaria leaf spot**
  - *Alternaria alternata*, *A. arborescens*, *A. tenuissima*

- **Anthracnose**
  - *Colletotrichum acutatum*

- **Bacterial spot**
  - *Xanthomonas arboricola pv. pruni*
Timing of Alternaria leaf spot treatments

• Inoculum is omnipresent in orchards.
• Alternaria leaf spot is greatly influenced by microclimatic conditions within orchards.
• The DSV (Disease Severity Value) Model was originally developed for forecasting black mold of tomato caused by *A. alternata*.
• We evaluated the model for forecasting the disease on almond and adapted the temperature parameters.

### The modified DSV model

<table>
<thead>
<tr>
<th>Mean temperature (°C) during wetness</th>
<th>Leaf wetness duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 17</td>
<td>0 - 6 7 - 15 16 - 20 21 ---</td>
</tr>
<tr>
<td>17.1 - 20</td>
<td>0 - 3 4 - 8 9 - 15 16 - 22 23+</td>
</tr>
<tr>
<td>20.1 - 25</td>
<td>0 - 2 3 - 5 6 - 12 13 - 20 21+</td>
</tr>
<tr>
<td>25.1 - 29</td>
<td>0 - 3 4 - 8 9 - 15 16 - 20 23+</td>
</tr>
<tr>
<td>DSV</td>
<td>0 1 2 3 4</td>
</tr>
</tbody>
</table>

### Disease severity values (DSV) as a function of leaf wetness duration and average air temperature during the wetness period.
## Efficacy of Alternaria leaf spot treatments - 2014

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (oz/fl oz)</th>
<th>5/14</th>
<th>6/4</th>
<th>6/25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Isofetamid</td>
<td>17</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>EXP-1</td>
<td>5.14</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>EXP-1 + Headline</td>
<td>3.43 + 5.48</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>EXP-1 + EXP-2</td>
<td>3.43 + 4.57</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Isofetamid + IB18111</td>
<td>10.3 + 5.57</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D + Tebucon</td>
<td>6.2 + 8</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Fontelis + Tebucon</td>
<td>14 + 8</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Luna Experience</td>
<td>6</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>5</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Merivon</td>
<td>6.5</td>
<td>@</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Inspire Super*</td>
<td>20</td>
<td>@</td>
<td>---</td>
<td>@</td>
</tr>
<tr>
<td>Quadris Top*</td>
<td>14</td>
<td>---</td>
<td>@</td>
<td>---</td>
</tr>
<tr>
<td>Bravo Weather-Stick</td>
<td>64</td>
<td>@</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Quadris Top*</td>
<td>14 + 16</td>
<td>---</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D*</td>
<td>6</td>
<td>@</td>
<td>---</td>
<td>@</td>
</tr>
<tr>
<td>Tebucon</td>
<td>8</td>
<td>---</td>
<td>@</td>
<td>---</td>
</tr>
</tbody>
</table>

### Summary

- **Two to three applications in late spring based on a DSV-model threshold** (e.g., increases of 6-10 values of the 7-day index).
- **Most effective materials:** FRAC 7/11 combinations; FRAC 3+7, 3/9, 3/11, and 3+19 combinations.
- **Rotations and mixtures of FRAC Groups successful** - 

*No detections of new resistance*
The pathogen *Xanthomonas arboricola* pv. *prunii* overwinters in fruit mummies on the tree. Isolates evaluated to date were all copper-sensitive.

**Late dormant treatments** with copper, copper-mancozeb, or copper-mancozeb-captan significantly reduced the disease.

**In-season treatments** in the weeks following petal fall were most effective when timed around rain events and before temperatures started to rise.

All copper products significantly reduced disease. Kasumin (accepted in IR-4), Fireline/Mycoshield, and Serenade Optima were also effective.

The most effective management program:
1) A late dormant application to reduce inoculum;
2) At least one or two in-season applications around rainfall events and rising temperatures to prevent new infections.

(see poster for details)
Thank you
Danke
Gracias
Merci
Cheers
شكرا
谢谢
ありがとうございます
धन्यवाद
спасибо
Dr. J. E. Adaskaveg
Department of Plant Pathology
University of California, Riverside
Thank You