Spray Coverage: The Missing Link in PM
Spraying Basics: Safe, Effective, Efficient and Sustainable.

Franz Niederholzer
U.C. Farm Advisor
Colusa/Sutter/Yuba Counties
Objectives in Almond Spraying

Slide concept: Dr. Ken Giles, UC Davis
Talk Objectives

• Review basic spraying terms and conditions

• Review optimization of conventional airblast sprayers for pest and drift control in almonds
Droplet Size and Surface Coverage

250 microns

500 microns

1,000 microns

NDSU Agriculture Communication
<table>
<thead>
<tr>
<th>Droplet diameter (µm)</th>
<th>drops/cm² from 1 liter volume</th>
<th>Fall time from 10’ height</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>19,099</td>
<td>17 min.</td>
</tr>
<tr>
<td>20</td>
<td>2387</td>
<td>240 sec</td>
</tr>
<tr>
<td>50</td>
<td>153</td>
<td>40 sec</td>
</tr>
<tr>
<td>100</td>
<td>19</td>
<td>11 sec</td>
</tr>
<tr>
<td>200</td>
<td>2.4</td>
<td>4 sec</td>
</tr>
<tr>
<td>500</td>
<td>&lt;0.5</td>
<td>2 sec</td>
</tr>
<tr>
<td>Droplet size (initial)</td>
<td>Time to dry</td>
<td>Time to dry</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>50 µm</td>
<td>14 sec</td>
<td>4 sec</td>
</tr>
<tr>
<td>100 µm</td>
<td>57 sec</td>
<td>16 sec</td>
</tr>
<tr>
<td>200 µm</td>
<td>227 sec</td>
<td>65 sec</td>
</tr>
</tbody>
</table>

G.A. Matthews, Pesticide Application Methods 3\textsuperscript{rd} ed.
Where to start for good coverage?

• D4-6
• 25 (2 hole) swirl plates
• 125 – 150 psi
Where to start for drift control?

• D8-12
• D25 (2 hole) swirl plates
• 125 – 150 psi
• Less sprayer fan air?
• More spray volume to compensate for larger droplets?
Practices that improve pesticide deposition on the target crop also reduce potential for pesticide drift and pesticide runoff from the orchard.
Calibration is an important legal and logistical step.
Basic Calibration

GPA = GPM/APM

GPA = Spray rate

Land rate
Accurate calibration does not insure effective coverage.
Basic equipment adjustments for spray targeting

- Air flow (direction/volume)
- Droplet size/spray volume
- Nozzle orientation
Air blast sprayers are air-carrier sprayers

Sufficient air volume is needed to move the spray thought out the target canopy...
Air blast sprayers are air-carrier sprayers.

Sufficient air volume is needed to move the spray thought out the target canopy... but no further.
Spray Volume
35 gpa at 3 mph

75 gpa at 3 mph

A. Landers, Cornell Univ.
Engine Drive, 150 gpa, 2 mph, Double Bank of nozzles, Intrepid 20 oz, Larger Almonds, Fresno County
Loss with Height Degradation
150 gpa
Better than
100 gpa
Just going from 1.8 to 2.2 mph reduced volume by 32%
Nozzle adjustment/placement
How do you check for proper tree coverage?

• Water
• Surround™
• Water sensitive paper
• Food coloring and photographic paper
Review

- Proper calibration (dial-in GPA)
- Balanced air delivery
  - Light on air early in the season
  - Full air as the canopy closes
- Sufficient volume to give good coverage once adequate carrier air is delivered
- Nozzle selection and orientation to effectively and efficiently target the canopy
Thank you
Evaluation of Insecticide Efficacy and Spray Coverage in Mature Almond Orchards – Kern County

Bradley S. Higbee
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Paramount Farming Co.
Bakersfield, CA, 93306
Navel Orangeworm Biology

- Pyralidae
- Highly polyphagous
- Primary pest of almonds and pistachios
- High dispersal capacity
- Multivoltine

- Oviposition and feeding directly on nut
Insecticide Trials at Paramount

Trials

- 2 – 3 per Year
- 20 acre plot size
- 3 or 4 Replicates
- Testing Pyrethroids and Reduced Risk Chemistries
# 2009-2011 Insecticide Trials

## NOW Insecticide control trial - Almond - 2009

<table>
<thead>
<tr>
<th>Targets</th>
<th>Timing</th>
<th>Actual date</th>
<th>Deg days</th>
<th>Biofix</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-150 DD 1st</td>
<td>100-250 DD 2nd (1% HS)</td>
<td>100-200 DD 3rd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trtmnt</td>
<td>1st Treatment</td>
<td>2nd Treatment</td>
<td>3rd Treatment</td>
<td></td>
</tr>
<tr>
<td>April/May</td>
<td>HS June</td>
<td>Post HS July/Aug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>No Treatments</td>
<td>4/10</td>
<td>160</td>
<td>15-Mar</td>
</tr>
<tr>
<td>2</td>
<td>Brigade - 100gals/ac</td>
<td>7/3</td>
<td>1521</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Brigade - 200gals/ac</td>
<td>7/23</td>
<td>2032</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Intrepid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Brigade Intrepid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Belt Intrepid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Altacor Intrepid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Intrepid Intrepid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Estimated date:** Mar 18 - Apr 14, June 7 - July 3, July 25 - Aug 8
NOW Control in Almond - 2009
Infested nuts - All Varieties

Percent of nuts infested

F = 12.94
p < 0.0001
Tukey-Kramer

59% Reduction
88% Reduction
47% Reduction

<table>
<thead>
<tr>
<th></th>
<th>Percent of Nuts Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.4</td>
</tr>
<tr>
<td>Br100</td>
<td>1.4 (bc)</td>
</tr>
<tr>
<td>Br200</td>
<td>1.5 (bc)</td>
</tr>
<tr>
<td>Int-Br</td>
<td>0.4 (c)</td>
</tr>
<tr>
<td>Br-Int</td>
<td>1.9 (b)</td>
</tr>
<tr>
<td>Beltx2</td>
<td>2.4 (ab)</td>
</tr>
<tr>
<td>Altax2</td>
<td>3.1 (a)</td>
</tr>
<tr>
<td>I x 3</td>
<td>1.8 (b)</td>
</tr>
</tbody>
</table>

---1 application---
-------------------
2 applications----------
3 apps
NOW Control in Almond 1 - 2010
Infested nuts - All Varieties

Control
Br100
Br200
Int-Br
Br-Int
Beltx2
Altax2
I x 2

Percent of nuts infested

F = 3.55
p = 0.0012
Bonferroni PCT

32% Reduction
47% Reduction
68.5% Reduction

---1 application---
-------------------
2 applications
NOW Control in Almond 1 - 2011
Infested nuts - All Varieties

F = 3.65
p = 0.0008
Bonferroni PCT

53% Reduction

Percent of nuts infested

Control  Br100  Br200  Int-Br  Br-Int  Beltx2  Altax2  Intr x 2

1 application 2 applications

--- ---
0 5
<table>
<thead>
<tr>
<th>NOW Insecticide control trial 1 - Almond - 2012</th>
<th>R3400, 3410, 3470</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timing</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Targets</strong></td>
<td>1st HS/1100 dd</td>
</tr>
<tr>
<td><strong>Treatments</strong></td>
<td>Early HS</td>
</tr>
<tr>
<td>1</td>
<td>No Treatments</td>
</tr>
<tr>
<td>2</td>
<td>Brigade+Intrepid</td>
</tr>
<tr>
<td>3</td>
<td>Brigade+Intrepid</td>
</tr>
<tr>
<td>4</td>
<td>Brigade+Intrepid</td>
</tr>
<tr>
<td>5</td>
<td>Brigade</td>
</tr>
<tr>
<td>6</td>
<td>Intrepid</td>
</tr>
<tr>
<td>7</td>
<td>Belt</td>
</tr>
<tr>
<td>8</td>
<td>Altacor</td>
</tr>
<tr>
<td><strong>Estimated date</strong></td>
<td>June 10 - 25</td>
</tr>
<tr>
<td><strong>Actual date</strong></td>
<td>June 23</td>
</tr>
<tr>
<td><strong>Deg days</strong></td>
<td>1230</td>
</tr>
<tr>
<td><strong>Biofix</strong></td>
<td>7-Mar</td>
</tr>
</tbody>
</table>
NOW Control in Almond 1 - 2012
Damage - All Varieties

F = 9.81
p < 0.001
Tukey-Kramer

Percent NOW damage

Control  Br+Intrep early  Br+Intrep HS  Br+Intrep Late  Brigade  Intrepid  Belt  Altacor

12.8  8.3  10.8  6.6  9.9  10.6  11.3  11.5

abc  cd  abc  d  bc  abc  ab  ab

48% Reduction
Can we improve performance?

- Trials evaluating efficacy of reduced risk (primarily ovi-larvicides) insecticides typically result in a maximum of 50-60% damage reduction in almonds vs NOW
- These same products have better results in other crop-pest systems (such as Apples/codling moth)
- Target site for residues is the almond
- Suspected problems:
  - Canopy density
  - Spatiotemporal dynamics of nut split/susceptibility
- Evaluate spray coverage, identify weaknesses
Spray Coverage Trials 2010-2012
Orchard Characteristics

- Nonpareil and Monterey varieties, in 1:1 ratio, planted in alternating rows, 21 ft (m) x 24 ft
- Orchard planted in 1999 (12 yrs at time of study in 2010), hedged in 2009 and 2012
- Mean distance between tree canopies in drive row = 3.1 ft (0.5 – 4 ft)
- Mean height above ground (measured to highest nut), NP = 20.5 ft, range 19-24 ft; Mo = 15.8 ft, range 14.5-18 ft
- Canopy radius at base, NP = 9.5 ft (19 ft diameter)
Overview
Trials conducted in 2010, 2011 and 2012

- 8 treatments (including control)- using chloroantraniliprole (Altacor®) @ 4.5 oz/ac along with surfactant (Li-700) @ 0.125% (v/v) in 2010, 0.25% (v/v) in 2011, 0.08% (v/v) in 2012 and Fujimite @ 2 pts/ac all years – One application at HS
- 8 ac plots, 3 replicates, Nonpareil/Monterey varietal mix
- Sampling:
  - Spray cards – water sensitive papers (WSP) (26 x 76mm = 1” x 3”) – 2 trees/plot, 6 trees/treatment – digital analysis, CIAS 2.0
  - Hull residues - LC//MS/MS – 2 trees/plot, 6 trees/treatment
  - Harvest samples – evaluate NOW infestation
  - Nut samples from 2 trees/plot at 4 vertical heights just prior to harvest – ”Tree samples”
  - Nut samples from ground (6 trees /plot) after shaking – “Ground samples”
WSP and Nut Residue Sampling Positions

10/tree

Levels

- Level 1 – Lower canopy, 6-8 ft
- Level 2 – mid-canopy, 10-12 ft
- Level 3 – upper canopy, 14-16 ft
- Level 4 – top of canopy, 18+ ft

Positions

- Levels 1-3
- Position 1 – outer periphery
- Position 2 – central interior
- Position 3 – lateral periphery
Sprayer Technology

Air O Fan D-2/40 500

Progressive Ag 3 head 2650 w/ 16 ft tower

Blueline Accutech 10 head tower

Progressive Ag 2 head 2650 w/ 13 ft tower

Progressive Ag 2650
Coverage and residue deposition tended to be greater at slower speeds by 30-40%.

The best treatments in these tests only resulted in about 50% coverage overall.

Electrostatic treatments did not perform well on the WSPs (small droplet size is a suspected), but they were among the best in residue deposition at full volume and delivered surprising residues at high speeds/low volumes.

Tower sprayers had the most consistent coverage and residues across vertical levels.

For the conventional ground-based sprayers, most of the residues were deposited in the lower half of the tree while the highest levels of NOW infestation occurred in the upper half of the tree.

None of these spray approaches resulted in the coverage required for optimum performance of ovi-larvicidal products. However, we plan to address these shortcomings and hope to improve this performance in our 2012 trial.
Damage Reductions from 2010 Trial

Almond Spray Coverage Trial - 2010
NOW Infested nuts from Tree/level samples - NP
% Reduction relative to controls

- AOF 2.5
- AOF 2.0
- PA 200
- PA 50
- PA Tower
- Blu Tower

B. Higbee, Paramount Farming Co.
### 2012 Coverage Trial
#### 2 Applications of Altacor® - 6/29 & 7/25

**NOW Spray Coverage Trial - Almond - 2012**

<table>
<thead>
<tr>
<th>Trtmnt</th>
<th>Manufacturer</th>
<th>Model</th>
<th>mph</th>
<th>gals/ac</th>
<th>Core</th>
<th>Nozzles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AOF (2010)</td>
<td>D-2/40 500</td>
<td>2.5</td>
<td>200</td>
<td>45</td>
<td>#7 x 8, #6 x 1</td>
</tr>
<tr>
<td>2</td>
<td>AOF (2010)</td>
<td>D-2/40 500</td>
<td>2</td>
<td>200</td>
<td>45</td>
<td>#6 x 8, #5 x 1</td>
</tr>
<tr>
<td>3</td>
<td>Hollow Cone</td>
<td>D-2/40 500</td>
<td>2.5</td>
<td>200</td>
<td>45</td>
<td>#4-x1, #10x3, #8x3, #6x2</td>
</tr>
<tr>
<td>4</td>
<td>Full Cone</td>
<td>D-2/40 500</td>
<td>2.5</td>
<td>200</td>
<td>35 (D5 only) #TG5x5, #D5x4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Flat Fan</td>
<td>D-2/40 500</td>
<td>2.5</td>
<td>200</td>
<td>35 (D5 only) #TG5x5, #D5x4</td>
<td></td>
</tr>
<tr>
<td>*6</td>
<td>AOF 2 boom</td>
<td>D-2/40 500</td>
<td>2.5</td>
<td>200</td>
<td>45x4, 25x5 #7-#7 x 4, #4-#4 x 2, #3-#3 x3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Prog Ag 150</td>
<td>2650 16' Tower</td>
<td>3</td>
<td>150</td>
<td>3 manifolds, 3/8' air shear</td>
<td></td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>Control</td>
<td>Miticide only</td>
<td></td>
<td></td>
<td></td>
<td>same as #1</td>
</tr>
</tbody>
</table>

* 2 booms **Treat first

---

**Air O Fan**  
D-2/40 500

**Progressive Ag 3 head**  
2650 w/ 15 ft tower
Water Sensitive Papers

PFC/Dupont Spray Coverage Trial - 2012
% Coverage of WSPs on nuts - based on 452,000 pixels

Percent coverage

<table>
<thead>
<tr>
<th>Level</th>
<th>AOF 2.5</th>
<th>AOF 2.0</th>
<th>Hollow</th>
<th>Full</th>
<th>Flat</th>
<th>AOF 2 boom</th>
<th>PA 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8 ft</td>
<td>72</td>
<td>69</td>
<td>66</td>
<td>67</td>
<td>70</td>
<td>53</td>
<td>42</td>
</tr>
<tr>
<td>10-12 ft</td>
<td>53</td>
<td>48</td>
<td>43</td>
<td>54</td>
<td>49</td>
<td>36</td>
<td>42</td>
</tr>
<tr>
<td>14-16 ft</td>
<td>27</td>
<td>25</td>
<td>22</td>
<td>25</td>
<td>21</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>18+</td>
<td>11</td>
<td>15</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Overall</td>
<td>46</td>
<td>44</td>
<td>40</td>
<td>44</td>
<td>41</td>
<td>49</td>
<td>32</td>
</tr>
</tbody>
</table>

- AOF 2.5
- AOF 2.0
- Hollow
- Full
- Flat
- AOF 2 boom
- PA 150

Water Sensitive Papers
Altacor® Residues

PFC/Dupont Spray Coverage Trial - 2012
Mean Altacor residues at Different Tree Heights

- AOF 2.5
- AOF 2.0
- Hollow
- Full
- Flat
- AOF 2 boom
- PA 150

Mean µG/nut

<table>
<thead>
<tr>
<th>Level</th>
<th>6-8 ft</th>
<th>10-12 ft</th>
<th>14-16 ft</th>
<th>18+</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOF 2.5</td>
<td>6.1</td>
<td>4.1</td>
<td>2.0</td>
<td>0.9</td>
<td>3.5</td>
</tr>
<tr>
<td>AOF 2.0</td>
<td>7.4</td>
<td>5.4</td>
<td>2.7</td>
<td>0.9</td>
<td>4.9</td>
</tr>
<tr>
<td>Hollow</td>
<td>6.6</td>
<td>2.4</td>
<td>1.6</td>
<td>0.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Full</td>
<td>8.5</td>
<td>4.9</td>
<td>2.5</td>
<td>0.9</td>
<td>4.6</td>
</tr>
<tr>
<td>Flat</td>
<td>7.0</td>
<td>5.7</td>
<td>2.6</td>
<td>0.9</td>
<td>4.7</td>
</tr>
<tr>
<td>AOF 2 boom</td>
<td>5.7</td>
<td>5.1</td>
<td>1.1</td>
<td>0.8</td>
<td>4.3</td>
</tr>
<tr>
<td>PA 150</td>
<td>6.1</td>
<td>4.1</td>
<td>2.0</td>
<td>0.9</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Levels: 6-8 ft, 10-12 ft, 14-16 ft, 18+, Overall
Almond Spray Coverage Trial - 2012
NOW Infested nuts from Tree/level samples - NP

Sampled Aug 24

- AOF 2.5
- AOF 2.0
- Hollow
- Full
- Flat
- AOF 2 boom
- PA 150
- Control

Percent infested

Elevation

6-8
10-12
14-16
18+
Overall

0 5 10 15 20 25 30 35 40
Almond Spray Coverage Trial - 2012
NOW Infested nuts from Tree/level samples - NP
% Reduction relative to controls

<table>
<thead>
<tr>
<th></th>
<th>Lower Canopy 2-4 m (6-12 ft)</th>
<th>Upper Canopy - 5-6 m (14-18+ ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOF 2.5</td>
<td>74.8</td>
<td>33.5</td>
</tr>
<tr>
<td>AOF 2.0</td>
<td>70.7</td>
<td>35.2</td>
</tr>
<tr>
<td>Hollow</td>
<td>66.6</td>
<td>60.6</td>
</tr>
<tr>
<td>Flat</td>
<td>59.3</td>
<td>47.8</td>
</tr>
<tr>
<td>AOF 2 boom</td>
<td>60.6</td>
<td>47.8</td>
</tr>
<tr>
<td>PA 150</td>
<td>68.9</td>
<td>19.1</td>
</tr>
</tbody>
</table>

Percent Reduction
Almond Spray Coverage Trial - 2012
NOW Infested nuts from Tree/level samples - NP

Sampled Aug 24

51% Reduction
50% Reduction
56% Reduction
45% Reduction
36% Reduction
33% Reduction
40% Reduction

F = 3.76
p < 0.001

9.02 9.16 8.17
10.22
11.77 12.35 11.08
18.50
0
5
10
15
20
25

AOF 2.5 AOF 2.0 Hollow Full Flat AOF 2
boom
PA 150
Control
Almond Spray Coverage Trial - 2012
NOW Infested nuts from ground samples - NP

Sampled Aug 30

F = 57.163
p < 0.0001
Tukey-Kramer

Percent infested

66% Reduction
5.9 bc
AOF 2.5

62% Reduction
6.6 b
AOF 2.0

76% Reduction
4.1 c
Hollow

70% Reduction
5.3 bc
Full

70% Reduction
5.2 bc
Flat

69% Reduction
5.4 bc
AOF 2 boom

72% Reduction
4.9 bc
PA 200

17.3 a
Control

69% Reduction
62%
Reduction
66%
Reduction
70%
Reduction
72%
Reduction

69%
Reduction
62%
Reduction
76%
Reduction
5.9 6.6
4.1 5.3 5.2 5.4 4.9
17.3
0
3
6
9
12
15
18
21
AOF 2.5 AOF 2.0 Hollow Full AOF 2 boom
PA 200 Control

abcbc b c bcbc bc
Altacor Spray Coverage Trial - 2012
NOW Infested nuts from ground samples - Mo

Sampled Oct 2

Percent infested

F = 3.01
p < 0.005
Tukey-Kramer

40% Reduction

40% Reduction

12.9
10.3
9.9
8.5
9.4
8.3

ab
ab
ab
b
ab
b
ab
ab
ab

12.3
13.9

AOF 2.5
AOF 2.0
Hollow
Full
Flat
AOF 2 boom
PA 150
Control
Almond Insecticide Spray Coverage Trial 2012

- **Mean number of eggs or males/week**

**2012 Eggs**

**Males-2012**

- **1st Apps**
  - June 29
  - 1332 dd

- **2nd Apps**
  - July 25
  - 1890 dd

- **NP HS begin**
  - June 18

- **21 days**

- **Tree Samps**
  - 8/24
  - 2644 dd
  - 80% egg-2n

- **2nd Apps**
  - July 25
  - 1890 dd

- **8/16**
  - 300 dd

**Timeline:**
- 3/6
- 3/27
- 4/17
- 5/8
- 5/29
- 6/19
- 7/10
- 7/31
- 8/21
- 9/11
- 10/2
- 10/23
Tentative, unofficial and possibly meaningless rankings

8 points for top performer, 2 for bottom in each category

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Points</th>
<th>No WSP for Prog Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.5</td>
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</tr>
<tr>
<td></td>
<td>5.2</td>
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<tr>
<td></td>
<td>4.7</td>
<td></td>
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<tr>
<td></td>
<td>4.0</td>
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</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Residues</th>
<th>WSPs</th>
<th>Tree-Infest</th>
<th>Grnd Mo i</th>
<th>Grnd-NP Inf</th>
<th>Pole WSP</th>
<th>Total</th>
<th>Rank</th>
<th>Avg</th>
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<tbody>
<tr>
<td>6 AOF 2 boom</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>35</td>
<td>1</td>
<td>5.8</td>
</tr>
<tr>
<td>4 Full Cone</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>33</td>
<td>2</td>
<td>5.5</td>
</tr>
<tr>
<td>5 Flat Fan</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>33</td>
<td>2</td>
<td>5.5</td>
</tr>
<tr>
<td>3 Hollow Cone</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>31</td>
<td>4</td>
<td>5.2</td>
</tr>
<tr>
<td>1 AOF (2010) 2.5</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>28</td>
<td>5</td>
<td>4.7</td>
</tr>
<tr>
<td>7 Prog Ag 150</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>26</td>
<td>6</td>
<td>5.5</td>
</tr>
<tr>
<td>2 AOF (2010) 2.0</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>24</td>
<td>7</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Spray Coverage Trials

- Two application programs make a big difference
- Incremental improvements made with 2 booms, full cone and hollow cone nozzles
- Trends among metrics not consistent
- Maybe coverage is not the driving force?
- Combine with aerial applications?
Acknowledgements

Dupont Crop Protection – Ray Kazmarcyck
Paramount Farming Co.
PFC Entomology Research Group

Technical assistance:
Ashlee Pedro         Daniel Vargas
Gabrielle Chrisco    Fernando Higuera
Lori Smith           Emmanuel Higuera
Allie Ruettgers      Kyle Lemucchi
Johnny Magana        Vince Phillips
Eddie Placentia
Yogi Berra

“In theory, there is no difference between theory and practice. But in practice, there is.”
Orchard Spraying – New Technologies and Outlook

Ken Giles
Bio. & Ag. Engineering Dept.
UC Davis
Previous Discussion…

Droplet size effects

Need for proper nozzle placement and adjustment

Importance of air volume for displacing canopy

Balance between runoff, drift and efficacy
Improvements in Application

Top Priority – calibration, ground speed, air speed and monitoring of current technology.

Before buying new technology, give your existing technology the same attention you would give a new piece of equipment.

New technologies require more attention, especially at first.
Spray Drift

Drift from the SDTF Control Application

1.0 = 0.08 oz per acre

Why large buffer zones aren’t the answer

99.5% on crop
0.5% drift

Wind

Relative Drift

(ft)
Miller *et al.* (2003) concluded: “Most of the spray movement out of the tree canopy was in the spaces between trees…”

“One way to reduce drift may be to turn off the spray between tree crowns…”
Data from Spray Drift Task Force

Vertical Deposition Profile 1, 2 and 5 Rows Beyond Sprayer
(Almonds, Airblast Sprayer)

% of applied a.i.
Vertical Deposition Profile 1, 2 and 5 Rows Beyond Sprayer (Dormant Apples, Airblast Sprayer)

*4.4 mph Wind*

- Collector towers
- % of applied a.i.

Data from Spray Drift Task Force
Data from Spray Drift Task Force

Vertical Deposition Profile 1, 2 and 5 Rows Beyond Sprayer
(Dormant Apples, Airblast Sprayer)

12.2 mph Wind

Collector towers

Height (m)

% of applied a.i.
How open spaces between trees affect ground deposition

- Young grapefruit
- Grapefruit
- Oranges (standard)

Downwind Distance (ft)
<table>
<thead>
<tr>
<th>Author</th>
<th>Condition</th>
<th>Ground</th>
<th>Target</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seiber</td>
<td>Dormant</td>
<td>25 – 45%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cross</td>
<td>Both</td>
<td>43 - 63%</td>
<td>56 – 68%</td>
<td>16%</td>
</tr>
<tr>
<td>Vercruysse</td>
<td>Both</td>
<td>-</td>
<td>56 – 68%</td>
<td>-</td>
</tr>
<tr>
<td>Pergher</td>
<td>In season</td>
<td>-</td>
<td>37 – 62%</td>
<td>-</td>
</tr>
<tr>
<td>Fox</td>
<td>“Sparse”</td>
<td>57%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Miller</td>
<td>In season</td>
<td>22%</td>
<td>57%</td>
<td>4.6 (16%)</td>
</tr>
</tbody>
</table>
Case Study

Ultrasonic measurement of trees for control of spray sections.

Savings depends on orchard age, size, gaps, etc.

Some trials have shown 50 - 70 % savings.
Field test – dormant almonds

Nozzle configuration was “center-weighted” spray

0.5 kg/ha Lorsban (chlopyrifos)

Durand-Wayland AF500 Smart Sprayer
Field test – sampling
Field test – sampling

Tree samples, 2 m height

Ground samples
Performance results

Use of system had no significant effect on target deposition

Plum orchard –
• 15% reduction in a.i. rate
• 5% less ground deposit

Walnut orchard –
• 45% reduction in a.i. rate
• 58% less ground deposit

Almond orchard -
• 22% reduction in a.i. rate
• 71% less ground deposit
Performance results

Based on these results, a run-off experiment was conducted in a 40 acre prune orchard.
Performance

Spray Savings: 39%
Ground Deposit: -54%
Diazinon in Runoff: -44%
Economic Efficiency?

University of California Production Costs
Dept. of Agricultural and Resources Economics
- Cost and Return Studies

Sacramento Valley Almonds
San Joaquin Almonds
Economic Efficiency?

Annual cost of materials for disease and insect sprays

- $233  Sacramento Valley Almonds
- $203  San Joaquin Almonds

Variable application cost (labor and fuel) = $9.50 - $10.00 / acre
Assuming 20% material savings and 10% application cost savings, we can calculate “break even acreage”

160 acres

$15,000 investment and 2 year payback period
Improving Deposition / Control in Tops
Create air and fluid interaction among fans to generate turbulence that could improve uniformity and decrease drift.
Improving Deposition / Control in Tops

Fan Interaction: 70/30 Configuration
## Improving Deposition / Control in Tops

### Trial Configurations:

<table>
<thead>
<tr>
<th>Trial</th>
<th>Axial Fan Speed (Low/High/Off)</th>
<th>Axial Fan Nozzle Count</th>
<th>Upper Fan Nozzle Count</th>
<th>Upper Fans Speed (%)</th>
<th>Upper Fan Fluid (%)</th>
<th>Axial Fans Fluid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Low</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>Low</td>
<td>0</td>
<td>8</td>
<td>70</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>8</td>
<td>8</td>
<td>70</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>70/30</td>
<td>Low</td>
<td>8</td>
<td>8</td>
<td>70</td>
<td>70</td>
<td>30</td>
</tr>
</tbody>
</table>
Improving Deposition / Control in Tops

Control vs. 70/30

Upper Canopy

Middle Canopy

Lower Canopy

Tree 1 Control Trial

Tree 1 70/30 Trial
## Improving Deposition / Control in Tops

### Naval Orange Worm – 1 Day After Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Survival</th>
<th>Reduction</th>
<th>Eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>33.30% ± 47.10 A</td>
<td></td>
<td>2,130</td>
</tr>
<tr>
<td>Conventional</td>
<td>22.00% ± 41.40 B</td>
<td>33.93%</td>
<td>3,930</td>
</tr>
<tr>
<td>Multifan</td>
<td>12.40% ± 33.00 C</td>
<td>62.76%</td>
<td>2,540</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>15.90% ± 36.60 A</td>
<td></td>
<td>1,990</td>
</tr>
<tr>
<td>Conventional</td>
<td>1.70% ± 12.90 B</td>
<td>89.31%</td>
<td>2,250</td>
</tr>
<tr>
<td>Multifan</td>
<td>7.90% ± 27.00 C</td>
<td>50.31%</td>
<td>1,930</td>
</tr>
</tbody>
</table>
Improving Deposition / Control in Tops
Improving Deposition / Control in Tops
Questions