I. Optimizing Pheromone Release Rates of Aerosol Emitters to Manage Codling Moth in Walnuts

II. Field Efficacy Trials of a 50% Aerosol Rate for Codling Moth Control

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Reducing Costs of MD in Walnuts

• Reduced number of units per acre (1 per 2 acres) – based on plume studies

• Studies to reduce pheromone concentration per puff (‘08-11)
  – Reductions up to 50% appear possible based on plume studies and field shut down, but efficacy trials underway

• Fixed cost of emitters becoming increasing proportion of materials cost
Changes in Walnut MD

(Not real dollars - hypothetical)

<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>Current</th>
<th>50% Rate</th>
<th>6 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Other</td>
<td>25%</td>
<td>25%</td>
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<tr>
<td>Cabinet</td>
<td>25%</td>
<td>25%</td>
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<td>25%</td>
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<tr>
<td>Pheromone</td>
<td>25%</td>
<td>25%</td>
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</tbody>
</table>

1 unit / 2 ac
62.5%

Half pheromone

Half duration
43.75%
2012 Projects:

• Reducing Costs
  – Examine impact of reduced nightly emission period from aerosol emitters on trap capture
  – Evaluate field efficacy of 50% ai can load for suppressing CM damage in walnuts

• Improving Performance
  – Observe interaction of “puff” concentration and pulse frequency on pheromone plume
Impact of reduced emission time – Pacific Biocontrol Mister

- **Treatments:**
  - **12 hours** “ON”, 5 pm - 5 am
  - **7 hours** “ON”, 5 pm - 12 am
  - **0 hours**, Mister removed

- **Site:**
  - 40 acre hilltop walnut orchard
  - Varieties: Vina, Chandler
  - High CM pressure
Impact of reduced emission time – Pacific Biocontrol Mister

• Design:
  – Two 16-trap grids
    • 100 feet between traps
    • 1x Biolure bait
    • traps high (15 feet)
    • Treatment periods 1 week
  – Wild population
  – Single Isomate Mister each plot, standard load
  – Compare trap capture of downwind vs upwind traps
  – RBD, 2 replicates / block, 4 replicates total
2012: 12, 7, or 0 hr Emission Periods for Aerosol Emitters

Trap Capture in Downwind Traps vs Upwind Border Traps

- Trap capture variation
  - Cultivar differences
  - CM flight peak during trial period
- Upwind traps
  - Average 8 to 49 CM/trap
- Downwind trap captures (ave)
  - 12 hr treatment → 0 to 2 CM
  - 7 hr treatment → 0 to 2.5 CM
  - 0 hr treatment → 3.5 to 34 CM

<table>
<thead>
<tr>
<th>Average Number of CM per Trap</th>
<th>12 hours</th>
<th>7 hours</th>
<th>0 hours</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>upwind(7)</td>
<td>7/9, 8/13, 7/16, 8/6</td>
<td>7/23, 8/6, 7/23, 7/30</td>
<td>7/16, 7/30, 7/9, 8/13</td>
<td>12 hours, 7 hours, No Emission, Average</td>
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<tr>
<td>downwind(4)</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- North 12 hours (5pm-5am)
- South 7 hours (5pm-12am)
- No Emission
- Average
2012: Percent Reduction of Average Trap Capture in Downwind Traps Compared to Border Traps when Exposed to 12, 7, or 0 hr Pheromone Emission Periods

<table>
<thead>
<tr>
<th></th>
<th>12 hours (5pm-5am)</th>
<th>7 hours (5pm-12am)</th>
<th>No Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>7/9</td>
<td>7/23</td>
<td>7/16</td>
</tr>
<tr>
<td>South</td>
<td>8/13</td>
<td>8/6</td>
<td>7/30</td>
</tr>
</tbody>
</table>

-120% -100% -80% -60% -40% -20% 0%

7/9 7/16 8/6 8/23 8/7 7/30 7/9 8/13

12 hours 7 hours No Emission

Average

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<td>7/30</td>
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<td></td>
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</table>

- Suppression less than expected in pheromone treatments
  - Hilltop location with wind variation
- 0-hour treatments with downwind suppression
  - no clearance period between treatments

- NO difference 7 hr vs 12 hr emission
  - 12 hr treatment → 85 – 100%
  - 7 hr treatment → 90 – 100%
  - 0 hr treatment → 14 – 62%

P<0.01
Rate Effects on Plume Size and Shape on Wild CM Males

- **1%**: No clear plume observed with 1% ai per puff
- **10%**: Smaller, more narrow plume with 10% ai per puff
- **50%**: 50% and 100% rates with roughly similar plume size and shapes
Effects of Rates on Sterile CM Males in Walnuts

Relatively small plume with 1% ai per puff with little clear distinction between 10 and 50% plume
Summary:
Interaction of concentration and pulse frequency on pheromone plume

• No clear impact of different load-frequency emission strategies
• No clear impact of changing pulse frequency for low concentration emission
• Detailed analysis difficult due to many uncontrolled variables
  – Wind speed/direction, temperature, canopy structure, planting pattern
  – Possible trouble with one of the puffer units
Reduced rate aerosol applications –
Large plot efficacy trials using 50% of standard ai concentration

• **Product:**
  – Checkmate Puffer (*Suterra*)
  – Isomate Mister (*Pacific Biocontrol*)

• **Sites:** 8 total
  – 4 replicates (orchards) per product

• **Collaborative research:**
  – Welter lab
  – Joe Grant
  – Carolyn Pickel/
    Sara Goldman-Smith
Methods: Reduced rate aerosol applications

50%/100% Suterra Puffer Efficacy Trial
Riverbank, CA

Site information:
Variety: Ashley
Planted 1962
25' x 25'

Plot Example

• Treatments:
  – 50% rate
  – 100% rate (current % ai)
  – Grower Standard (no-pheromone)
  – All deployments at 1 unit / 2 acres

• Monitor
  – CM flight (combo lures)
  – 1x trap suppression
  – Canopy damage (July)
  – Harvest damage
Efficacy Trials: Reduced Rate Aerosol Emitters

Season Total CM Capture in COMBO/DA -Baited Traps

Season Total CM 1x Capture and Trap Shutdown
Reduced Rate Aerosol Emitters – Codling Moth Damage at Harvest

- Damage highly variable between sites
- Damage low all sites and all treatments
  - Only one GS > 1.0%
  - Two sites recorded no CM damage

Average Codling Moth Damage at Harvest (2012)

P = 0.2, NS
Summary

• Rate reductions with aerosol treatments may be achieved by more than one strategy
  – 50% rate trial (reduced ai concentration)
    • High 1x trap shutdown success
    • CM damage at harvest similar between both pheromone treatments though few sites with moderate GS pressure
  – 7-hour emission period trial (preliminary trail)
    • 1x trap shut down similar between standard (12 hour) and short night (7 hour) emission time

• Aerosol based MD products from multiple producers now available
  – Products appear to have similar impact / success
Concluding Statements

Walnuts continue to have success with MD, but variation between plots suggest other confounding factors still exist (canopy volume, tree height, untreated varieties, less efficacious insecticide coverage)

Opportunities exist for reducing the required total pheromone per acre

Increased numbers of emitters per acre possible with decreased pheromone costs; perhaps to reduce program (plume) variation (e.g. 1 unit: 1-1.5 acres)
Thank you
(‘86-2012)

• Frances Cave
• Randall Island Five
  – Elliots (Dave, Dave, and Rich)
  – Green and Hemly (Doug and family)
  – Lincoln Chan
  – F&W - Darryl Ferrara
  – George Myers / Chris Frieders

• Advisors
  – Jim Dahlberg / Bob Costano
  – Tom Wiseman / Quisenberry
  – Pat Weddle / Randy Hansen
  – Don Miller

• More
  – Carl Yuki -Steamboat
  – Duncan Smith -All the rest that I didn’t mention
Thank you
(‘86-2012)

• Pear Board / Pear Pest
  – Bob McClain / Jean Mari Peltier
• Extension
  – Chuck Ingel
  – Rachel Elkins
  – Bob Van Steenwyk
• Suterra – Tom Larsen
• Pacific Biocontrol – Don Thomson, Jack Jenkins,