Replant + Disease Management

Gabriele Ludwig, Moderator
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Continuing Education Units are available for most sessions.

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Replant + Disease Management

Presenters:

Jim Adaskaveg, Plant Pathology, UC Riverside

David Doll, UCCE Merced County

John Leahy, EPA, Pesticide Re-evaluation Division
Epidemiology and Management of Foliar Diseases in California

J. E. Adaskaveg, University of California

Cooperators:
Currently Registered and New Fungicides for Almond Production in California
Development of New Fungicides for Managing Almond Diseases

Single – fungicides- Inorganics and Conventional Synthetics

**Inorganics**
- Copper, Sulfur
  - **M1**: 1960s
- Ziram, (Maneb)
  - **M2**: 1940s
- Captan
  - **M3**: 1950s
- Bravo, Echo, Equus
  - **M4**: 1960s

**Benzimidazoles**
- Topsin-M, T-Methyl
  - **1**: 1970s

**Dithiocarbamates**
- Ziram, (Maneb)
  - **M2**: 1940s

**Phthalimides**
- Captan
  - **M3**: 1950s

**Isophthalonitriles**
- Bravo, Echo, Equus
  - **M4**: 1960s

**Guanidines**
- Syllit
  - **M6**: 1960s

**Dicarboximides**
- Rovral, Iprodione, Nevado
  - **2**: 1980s

**Sterol inhibitors (DMIs)**
- Rally, Laredo, Orbit, Indar, Quash, Inspire
  - **3**: 1970s – 1980s

**Syrilinopyrimidines**
- Vangard, Scala
  - **9**: 1990s

**Polyoxins**
- Ph-D
  - **19**: 1960s

**New in 2010 and beyond:**
- Ph-D, Inspire, Quash, Luna Privilege (fluopyram), Xemium (fluxapyroxad)

- Multi-site mode of action
- Single-site mode of action
- Reduced risk fungicides
Development of New Fungicides for Managing Almond Diseases

Conventional Synthetic Fungicides – Pre-mixtures

<table>
<thead>
<tr>
<th>Product</th>
<th>Year</th>
<th>2000s</th>
<th>2010s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine</td>
<td>7+11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>7+11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS703?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspire XT</td>
<td>3+3</td>
<td></td>
<td>2010s</td>
</tr>
<tr>
<td>Inspire Super</td>
<td>3+9</td>
<td></td>
<td>2010s</td>
</tr>
<tr>
<td>Adament</td>
<td>3+11</td>
<td>2000s</td>
<td></td>
</tr>
<tr>
<td>Quilt Xcel</td>
<td>3+11</td>
<td>2010s</td>
<td></td>
</tr>
<tr>
<td>Quadris Top</td>
<td>3+11</td>
<td>2010s</td>
<td></td>
</tr>
</tbody>
</table>

New

<table>
<thead>
<tr>
<th>Mode of Action</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBIs</td>
<td>3</td>
</tr>
<tr>
<td>SDHIs</td>
<td>7</td>
</tr>
<tr>
<td>Anilinopyrimidines</td>
<td>9</td>
</tr>
<tr>
<td>QoIs</td>
<td>11</td>
</tr>
</tbody>
</table>

Natural Products

- Regalia, Cerebrocide, Ph-D organic, Actinovate
- Natural products and a biocontrol that already are or potentially will be OMRI approved were evaluated for organic farming of almonds.
Management of Springtime Foliar Diseases of Almond

Blossom Blight and Shot Hole
Management of Brown Rot
Blossom Blight and Shot Hole*

• Most effective new fungicides:
  • **Brown rot:**
    • Single Fungicides: Quash (2.5 and 3.5 equally effective)
    • Pre-mixtures: Adament, Luna Sensation, as well as Inspire Super, Inspire XT, and Quilt Xcel (when used at high label rates)
  • **Shot hole:** Bravo, Quadris Top, Quilt Xcel, Syllit, (Abound, Rovral)
  • Natural products/biocontrols: Actinovate, Regalia, and Cerebrocide showed some activity, but were not as effective as most fungicides. Actinovate was the most consistent.

*See poster for details*
Natural Host Resistance Against Brown Rot Blossom Blight
Natural Host Susceptibility of Almond Cultivars Against Blossom Blight

The relative susceptibility against blossom blight was mostly consistent among almond varieties over three years.
Management of Late-spring/Summer Foliar Diseases of Almond

Rust, Scab, Alternaria Leaf Spot, Jull Rot
Management of Almond Leaf Rust

Most effective new fungicides:
- Materials that included a QoI compound (e.g., Abound, Adament, Quadris Top, Quilt Excel, Pristine) were among the most effective fungicides
- The DMIs (Quash, Tilt, Inspire) and Ph-D also significantly reduced the incidence of disease
- Chlorothalonil (e.g., Bravo) was also highly effective, but this fungicide is currently only registered for use up to 150 days of harvest (changes pending)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>4-29</th>
<th>5-18</th>
<th>6-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Ph-D 11.2DF 6.2 oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Tilt 3.6EC 8 fl oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Quash 50WG 3.5 oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Inspire EC 7 fl oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Abound 2F 12.5 fl oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Gem 500SC 3 fl oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Bravo 96 fl oz</td>
<td>---</td>
<td>@ @</td>
<td>f</td>
</tr>
<tr>
<td>Adament 50WG 6 oz</td>
<td>---</td>
<td>@ @</td>
<td>f</td>
</tr>
<tr>
<td>Quadris Top 20 fl oz</td>
<td>---</td>
<td>@ @</td>
<td>cdef</td>
</tr>
<tr>
<td>Quilt Excel 14 fl oz</td>
<td>---</td>
<td>@ @</td>
<td>def</td>
</tr>
<tr>
<td>Pristine 38WG 14.5 oz</td>
<td>---</td>
<td>@ @</td>
<td>f</td>
</tr>
<tr>
<td>Manzate Pro-Stick 76.8 oz</td>
<td>@</td>
<td>---</td>
<td>f</td>
</tr>
<tr>
<td>Ph-D 11.2 DF 6.2 oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Adament 50WG 6 oz</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Bravo 96 fl oz</td>
<td>@ @</td>
<td>---</td>
<td>f</td>
</tr>
<tr>
<td>Quilt Excel 14 oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Quadris Top 20 oz</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Ph-D 11.2DF 6.2 oz</td>
<td>@ @</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Quash 50WG 3.5 oz</td>
<td>---</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>Ph-D 6.2 oz + Quash 2.5 oz</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

cv. Carmel, Colusa Co.

*See poster for details*
Management of Scab

1. Dormant applications to reduce inoculum in the spring

<table>
<thead>
<tr>
<th>2010 Treatments</th>
<th>Jan.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>---</td>
</tr>
<tr>
<td>Kocide 3000 5 lb - Cohere</td>
<td>@</td>
</tr>
<tr>
<td>Kocide 3000 5 lb - Oil 4 gal</td>
<td>@</td>
</tr>
</tbody>
</table>

![Inc. of lesion sporulation (%)](image)

- Dormant treatments with copper-oil are most effective in reducing primary inoculum in spring.
- These treatments are not effective on final disease levels, but they should be included into any scab program because the risk for selection for fungicide resistance is reduced when less inoculum is exposed to in-season fungicides.
Management of Scab

2. In-season applications

<table>
<thead>
<tr>
<th>Treatment</th>
<th>3-wk PF</th>
<th>5-wk PF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Single</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syllit 4FL 2 pt</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Syllit 4FL 3 pt</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Dithane 75DF 6 lb</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D 11.2DF 6.2 oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Quash 50WG 3.5 oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Pre-mix and mixes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adament 50WG 6 oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Luna Sensation 500SC 5 fl oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Inspire Super 12 fl oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Quadris Top 14 fl oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Quilt Xcel 20 fl oz</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Ph-D 11.2DF 6.2 oz + Captan 80WP 3 lb</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>Rotation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine 38WG 14.5 oz</td>
<td>@</td>
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</tr>
<tr>
<td>Indar 2F 6 fl oz + Dithane F45 192 fl oz</td>
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</tr>
</tbody>
</table>

- Programs that start at onset of twig sporulation are more effective than those starting later in the spring
Management of Scab

New fungicides registered or planned for scab:

- Single-site MOA fungicides: Ph-D, Quash, Inspire, Syllit (pending)
- Pre-mixtures: Inspire Super, Quilt Xcel, Luna Sensation (pending)

Fungicide programs:

- A highly effective three-spray program should include dormant applications with copper-oil and two after-petal-fall (around twig infection sporulation) applications with chlorothalonil, possibly mancozeb (see below), captan, or ziram (all are multi-site fungicides that have a low potential of resistance development)
- Because maneb has been voluntarily canceled (2008/2009), mancozeb (e.g., Dithane) fungicides are being tested and are planned for future registrations
- Single-site fungicides should not be applied once disease is developing

Cultural practices: IPM and the Disease Triangle
## Management of Alternaria Leaf Spot – Field Efficacy Trials

**cv. Carmel - Colusa Co.**

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<td>Quash 50WG 3.5 oz</td>
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</tr>
<tr>
<td>Ph-D 6.2 oz + Quash 2.5 oz</td>
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</tbody>
</table>

**Evaluation on 9-9-10**

Lesions/leaf: 0 0.5 1 1.5 2
Tree defoliation rating (0-4): 2.5 0.5 1 1.5 2

- a
- b
- c
- d
Tree defoliation evaluated in August

Control

Ph-D + Inspire Super

or Ph-D + Quash
Management of Alternaria Leaf Spot

Most effective treatments:

• Mixtures of the Group 19 Ph-D (polyoxin-D) and the Group 3 fungicides (i.e., Inspire, Quash)

Other new fungicides with good activity:

• Luna Sensation, Adament, Quadris Top, Quilt Excel. These all have a QoI component and thus, will exacerbate QoI resistance

Fungicide resistance:

• Resistance against QoIs is common: whereas against SDHIs only at several locations at high levels

• Cross resistance within QoIs (Abound, Gem, etc.) and within SDHIs (boscalid, fluopyram, etc.)
Management of Alternaria Leaf Spot

Overview:

• Programs should start with petal fall applications that include Rovral and Bravo (performance is variable and depends on the occurrence of favorable conditions). Proposed label changes with Bravo are ongoing efforts.

• Late-spring/early-summer applications (based on the DSV model) with other materials

• New materials (e.g., Quash, Inspire, Ph-D, Quadris Top, Quilt Xcel, Luna Sensation) will 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
Management of Hull Rot - Laboratory Studies

- Hull is highly susceptible to infection during early to mid split stages of nut development
- Most susceptible at hull split stages: b2 through e
- Infection likely due to conducive environments, but apparently not due to moisture content of the hull (laboratory studies)
- This information is important for the timing of fungicide applications

Hull split stages based on the UC-IPM Manual for Almonds.
Management of Hull Rot – Field Studies

Field trials:
Hull rot caused mainly by *R. stolonifer*

Application cv. Nonpareil: 8-13-10, Evaluation on 9-9-10
Applications cv. Winters: 8-31, 9-10-10, Evaluation on 10-1-10
Management of Hull Rot

- High incidence of hull rot in 2010 due to early fall rains
- All fungicide treatments were similarly effective in reducing hull rot
- No differences in application timings, possibly because of the long hull split duration within an orchard where a similar number of nuts were in a susceptible stage at each fungicide timing
- Trials are also planned at locations where *Monilinia* spp. are the causal pathogens
Management of Hull Rot

• In 2010, PGRs were evaluated: ethephon increased rate of split (with some defoliation based on rate), gibberelvin delayed hull split. Fungicide efficacy was not affected by PGR treatments.

• For the most effective integrated management of hull rot, hull split should be induced simultaneously with proper water management (i.e., deficit irrigation). A fungicide could then be applied most effectively during the stages when susceptibility is high.
On-line Resources on Fungicides
EFFICACY AND TIMING OF FUNGICIDES, BACTERICIDES, AND BIOLOGICALS FOR DECIDUOUS TREE FRUIT, NUT, STRAWBERRY, AND VINE CROPS 2011

ALMOND
APPLE AND PEAR
APRICOT
CHERRY
GRAPE
KIWIFRUIT

PEACH
PISTACHIO
PLUM
PRUNE
STRAWBERRY
WALNUT

Jim Adaskaveg
Professor
University of California, Riverside

Doug Gubler
Extension Plant Pathologist
University of California Davis

Themis Michailides
Plant Pathologist
University of California, Davis
/Kearney Agricultural Center

Brent Holtz
Farm Advisor
University of California Cooperative Extension,
San Joaquin, Co.

UC Davis, Dept. of Plant Pathology
www.plpnem.ucdavis.edu

UC Kearney Agricultural Center
www.uckac.edu/plantpath

Statewide IPM Program
www.ipm.ucdavis.edu
Thank you
Present and Future Replant Considerations and Strategies
David Doll, UCCE Merced County
Field trial locations & start dates:

Madera County, San Joaquin Valley:
- 2003, Agriland, almond after almond (sandy loam) (fr. CSREES)
- 2006, Paramount, almond after almond (sandy loam)
- 2007, Agriland, almond after almond (sandy loam)
- 2009, Poythress, almond after almond (loam)

Fresno County, San Joaquin Valley:
- 2007, USDA-ARS Parlier, peach after plum (sandy loam)
- 2007, USDA-ARS Parlier, almond after peach (sandy loam)
- 2008, Berberian, Reedley, peach after peach (sandy loam)
- 2008, KAC, Parlier, almond after peach (sandy loam)
- 2008, USDA-ARS, Parlier, peach after peach (sandy loam)
- 2010, USDA-ARS, Parlier, almond and peach rootstocks x Tel C35 fum

Colusa County, Sacramento Valley:
- 2007, almond after almond, Nickels Estate (loam)

Merced County, San Joaquin Valley:
- 2009, Frago, almond after almond (sand)
- 2010, Littlejohn, almond after almond (sand)
1. Current control strategies for mitigating soilborne pathogens and nematodes upon replanting.

2. Future approaches in developing treatments for replant problems using reduced or no soil fumigants.
The Replant Problems

- **Abiotic factors** (physical, chemical conditions related to previous production)

- **Aggressive pathogens, pests** (*Phytophthora*, *Armillaria*, *Verticillium*, Ten-Lined June Beetle) – localized, not managed completely by fumigation

- **Plant-parasitic nematodes** (ring, lesion, root knot), approx. 35% of almond and fresh stone fruit acreage, 60% of cling peach acreage infested (McKenry)

- **Replant disease (RD)** Microbe-induced growth suppression; incidence nearly universal in *Prunus* after *Prunus*, but severity varies greatly

Symptoms of replant disease on almond
Abiotic Factors

Learn from the old orchard!

Aerial image through Google Earth, walking the field

Determine areas of variability and address
• Soil Modification – ripping, backhoeing, slip-plowing

• Irrigation system – High volume/low volume

• Rootstocks – Determine options for salinity, boron, alkalinity, high water table, etc.
Aggressive Pathogens

• Can affect any soil type; consider history of old orchard

• Fumigation is not able to completely eradicate, but reduce population

• Fumigants that include methyl bromide

• Provide conditions that favor a thorough fumigation

• Cultural Practices and Resistant Rootstocks for Phytophthora and Armillaria–Marianna 2624, Ishtara, Krymsk-86
Plant-Parasitic Nematodes - Symptoms

Ring Nematode - Bacterial Canker Complex

Rootknot Nematode – Galls on roots

Lesion Nematode – root damage
Plant-Parasitic Nematodes - Sampling
Interpreting Results:

Main Question:
Are they there, or not?

If not, fumigation is not needed for nematodes.

If so – how many are present?
Plant-Parasitic Nematodes – Sampling / Treatment

50-100 Nematodes per 1 Liter of Soil
1. Manage weeds for 1-2 years before orchard removal
2. If possible, cover crop with Piper Sudan Grass for one year
3. Plant Resistant Rootstocks
4. 6-8’ Row Strip fumigate with Telone at 33 gallon per treated acre

>100 Nematodes per 1 Liter of Soil
1. Same cultural practices as moderate populations
2. Broadcast fumigate fumigate with Telone at 33 gallon per treated acre
Nematode of Concern

### Recommended Rootstocks

<table>
<thead>
<tr>
<th>Nematode of Concern</th>
<th>Rootstocks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rootknot</strong></td>
<td>Nemaguard, Atlas, Viking, Peach-almond hybrid with Nemaguard Parentage</td>
</tr>
<tr>
<td><strong>Ring</strong></td>
<td>Avoid Peach-almond hybrids, Viking and Lovell</td>
</tr>
<tr>
<td><strong>Lesion</strong></td>
<td>Rootstocks with high vigor such as Peach-almond hybrids</td>
</tr>
</tbody>
</table>
Replant Disease - Symptoms

Healthy (L) and replant disease-affected (R) almond trees, Madera County 2007

<table>
<thead>
<tr>
<th>Fumigant, rate</th>
<th>Plot area treated</th>
<th>Cumulative yield (kernel pounds/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Control</td>
<td>None</td>
<td>370</td>
</tr>
<tr>
<td>Control</td>
<td>None</td>
<td>294</td>
</tr>
<tr>
<td>MB, 400 lb/a</td>
<td>Br. (100%)</td>
<td>482</td>
</tr>
<tr>
<td>MB, 400 lb/a</td>
<td>R. strip (38%)</td>
<td>424</td>
</tr>
<tr>
<td>Telone II, 340 lb/a</td>
<td>Br. (100%)</td>
<td>547</td>
</tr>
<tr>
<td>Telone II, 340 lb/a</td>
<td>R. strip (38%)</td>
<td>483</td>
</tr>
<tr>
<td>Telone C35, 535 lb/a</td>
<td>Br. (100%)</td>
<td>***637</td>
</tr>
<tr>
<td>Telone C35, 535 lb/a</td>
<td>R. strip (38%)</td>
<td>***696</td>
</tr>
<tr>
<td>IM:CP (50:50), 400 lb/a</td>
<td>Br. (100%)</td>
<td>***682</td>
</tr>
<tr>
<td>IM:CP (50:50), 400 lb/a</td>
<td>R. strip (38%)</td>
<td>***632</td>
</tr>
<tr>
<td>CP 400 lb/a</td>
<td>Br. (100%)</td>
<td>554</td>
</tr>
<tr>
<td>CP 400 lb/a</td>
<td>R. strip (38%)</td>
<td>***680</td>
</tr>
</tbody>
</table>
Replant Disease - Control

Fine texture soils do not tend to have as severe of replant disease problems

Fallow or cover crop for at least one year

Fumigate row strips with chloropicrin containing fumigants

Switching rootstock parentage may provide some control, but sacrifices other horticultural benefits
## Replant Problems – Fumigant Selection

<table>
<thead>
<tr>
<th>Problem</th>
<th>Fumigant</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nematode Parasitism</td>
<td>Telone II or Telone C35</td>
<td>Broadcast or Row Strip</td>
</tr>
<tr>
<td>Replant Disease</td>
<td>Chloropicrin or Telone C35</td>
<td>Row Strip or Tree Site</td>
</tr>
<tr>
<td>Aggressive Pathogens</td>
<td>Chloropicrin/ Methyl Bromide</td>
<td>Broadcast</td>
</tr>
</tbody>
</table>
1. Current control strategies for mitigating soilborne pathogens and nematodes upon replanting.

2. Future approaches in developing treatments for replant problems using reduced or no soil fumigants.
Development of spot treatments

Early spot fumigation by “hand probe”

Growth in spot fumigated site
Growth in non-fumigated site
Growth and 1st year yield response of almond to pre-plant spot fumigation treatments with chloropicrin (0.25 to 2.0 lb / tree site), Butte County
GPS-controlled shank spot fumigation -
Upadhyaya et al. in collaboration with TriCal, Inc.

GPS-controlled shank spot application of fumigant in Fall 2006 (L) and Fall 2009 (R)
Drip spot fumigation

- Effective, but commercial feasibility limited by low-flow risk of CP damage to irrigation system PVC
- Strip drip fumigation, improved emulsification are possible solutions
- Key is to use available crop irrigation system
- Spot fungicide concept be tested
# Replant Problems – Fumigant Reduction

2008, USDA-ARS, Parlier, peach after peach (sandy loam)

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Fumigant per treated acre (lbs)</th>
<th>Fumigant per orchard acre (lbs)</th>
<th>Mkt. fruit yield (lb/ac) 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>6,171</td>
</tr>
<tr>
<td>Telone C35 Row Strip – 8.3’</td>
<td>540</td>
<td>227</td>
<td>31,527</td>
</tr>
<tr>
<td>Telone C35 Tree Site – 5’x6’</td>
<td>540</td>
<td>81</td>
<td>19,911</td>
</tr>
<tr>
<td>Telone C35 Inline – 4’ diameter</td>
<td>540</td>
<td>43</td>
<td>19,094</td>
</tr>
</tbody>
</table>
Soil Steaming

- Collaborative project, Hanson, Fennimore, Browne, Doll, Almond Board of CA
- Augers built by Weimer, Fennimore- 2.5’ & 3.0’ diameter
- Tree and spot responses pending
- Not without potential environmental impacts
Soil Augmentation

• Liquid injection auger can disperse agent or product within the soil
• Increases the likelihood of even distribution within the root zone
• Auger built by Weimer-2.5’ diameter
• Tree and spot responses pending
Present and Future Replant Considerations and Strategies - Conclusions

• Results indicate effectiveness of MB alternatives

• For replant disease, the most common replant problem, spot fumigation offers acceptable efficacy and fumigant rate and emissions reductions

• Other spot treatments (steam, fungicides) offer promise

• Results for fumigation and steam and treatments pending for nematode-infested sites

• Rootstock rotations to be further investigated

• Cultural contributions (soil ripping, irrigation, nutrition, safe weed management) critical to effective replant management
Acknowledgements:

Tri-Cal Fumigation Company

Weimer Manufacturing/Atwater Irrigation

Trial Hosts: Agriland, Berberian, Frago, Littlejohn, Nickel’s Estate, Paramount Farms, Poythress

Hunter Farms and Kruppa Farms for Excavation Services

Almond Board of California

Greg Browne – USDA-ARS leader for Area-Wide Methyl Bromide Alternatives Initiative

UCCE Advisors J. Connell, D. Doll, J. Edstrom, and B. Holtz

UC Specialists S. Fennimore, B. Hanson, B. Lampinen, and M. McKenry
Thank You
Reregistration Eligibility Decisions or “REDs”
Re-licensing decisions for chemicals used as soil fumigants
• Methyl Bromide
• Chloropicrin
• Metam Sodium/Metam Potassium
• Dazomet

First comprehensive reevaluation since products first registered
Soil Fumigant Review Goals

Protect workers and bystanders while maintaining key benefits of use

Ensure a level playing field across all soil fumigants

Make risk management decisions that are protective and that take into account likely real-world outcomes
Benefit and Risk Conclusions

Soil fumigation brings high benefits to growers
• Highly effective pest control tools
• Broad spectrum
• Increased revenue

Soil fumigation poses risks to applicators, workers, and bystanders
• Assessments based on multiple lines of evidence
  • Human and animal toxicity studies
  • Exposure based on monitoring and modeling
  • Incidents – effects, causes, distances observed
High risks + High benefits →

Package of measures that work together to:

- Reduce potential for direct exposure to toxic concentrations
- Reduce likelihood of accidents and errors
- Foster planning and compliance
- Assure appropriate response to exposures that occur
<table>
<thead>
<tr>
<th>Risk Mitigation Measure</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good agricultural practices (GAPs)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Restricted use (new measure for metam sodium/potassium &amp; dazomet only)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>New handler protections including changes to Respiratory protection, tarp cutting/removal and worker reentry restrictions</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fumigant management plans and post application summaries</td>
<td>●/●</td>
<td>●</td>
</tr>
<tr>
<td>Buffer zone distances, credits, and posting</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Emergency preparedness measures</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Difficult to evacuate sites</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Notice to state lead agencies</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Safe handling information</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>First responder, community outreach and certified applicator training</td>
<td>●/●</td>
<td>●</td>
</tr>
<tr>
<td>Rate reductions and use site limitations</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
Summary of Phase 1 Measures

Key Measures

First phase of Implementation late 2010

- Respiratory protection
- Tarp and entry restrictions
- Fumigant management plans
If experiencing sensory irritation, handlers must either:

1. Stop work and leave area
   OR
2. Wear a respirator & resume work

Note: air purifying respirators are required for all activities with methyl bromide products that have less than 20% chloropicrin
Tarp Perforation and Removal

Perforation
5 days after fumigant application is complete
• Exceptions for weather, flood prevention
Mechanical perforation required, except
• At the beginning of each row when a coulter blade is used on a motorized vehicle such as an ATV
• In fields that are 1 acre or less
• During flood prevention activities

Removal
• 2 hours after perforation is complete
Entry Restricted Period Scenarios
<table>
<thead>
<tr>
<th>If application is…</th>
<th>and tarp is…</th>
<th>_______ days after application is completed</th>
<th>workers may enter…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Untarped</td>
<td>-</td>
<td>-</td>
<td>5 days after application is complete</td>
</tr>
<tr>
<td>2. Tarped</td>
<td>Perforated and Removed</td>
<td>within 14 days</td>
<td>after tarp is removed</td>
</tr>
<tr>
<td>3. Tarped</td>
<td>Perforated BUT Not Removed</td>
<td>within 14 days</td>
<td>48 hours after perforating tarps</td>
</tr>
<tr>
<td>4. Tarped</td>
<td>Perforated and/or Removed</td>
<td>more than 14 days</td>
<td>5 days after application is complete</td>
</tr>
</tbody>
</table>
Purpose of the FMP:
- Ensure thorough planning
- Prevent accidents
- Identify appropriate emergency procedures
- Demonstrate compliance with label

FMP must be prepared and... 

Certified Applicator supervising the application must verify (sign and date) that it is accurate before fumigation begins.
Fumigant Management Plans (FMPs)

Major elements of a Phase 1 FMP:

- On-site applicator information
- General site information
- General application info
- Measurements taken to comply with GAPs
- Soil conditions, weather conditions
- Worker protections (tasks, PPE requirements, monitoring)
- Posting and record-keeping procedures
- Emergency response plans and procedures
Post Application Summary

- Deviations from FMP (e.g., date of application, tarps used, procedures, changes in personnel, etc.)
- Summary of actual weather
- Actual date of tarp activities and sign removal
- Description of problems, complaints, incidents
- Air monitoring results

Must complete within 30 days of application and kept with FMP for 2 years.
Fumigant Management Plans

What this means in California

- DPR developed a California specific template
- County Permit + NOI + Regulations + California FMP = Label required elements

Templates and Tools

- Federal EPA templates
  - Downloadable files and web-based templates
  - [www.epa.gov/oppsrrd1/reregistration/soil_fumigants](http://www.epa.gov/oppsrrd1/reregistration/soil_fumigants)
    Or internet search for . . .
    “soil fumigant implementation”

- California DPR template
- Company/grower specific templates
**2010 SOIL FUMIGANT MANAGEMENT PLAN (METHYL BROMIDE/CHLOROPRERIN PRODUCTS)**

The below text fields will expand as the text is entered. After completing each field, use Tab key to go to next text field or check box.

| I. Certified Applicator Supervising the Fumigation |
|---|---|---|---|
| Name: | Phone number: | License and/or certificate number: | Commercial applicator |
| Employer name: | Employer address: | Private applicator |

<table>
<thead>
<tr>
<th>II. General Site Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application block/field location (e.g., county, township-range-section quadrant), address including zip code, or global positioning system (GPS) coordinates:</td>
</tr>
</tbody>
</table>

| III. Owner/operator of Application Block |
|---|---|---|
| Name: | Address: | Phone number: |

<table>
<thead>
<tr>
<th>IV. Recordkeeping</th>
</tr>
</thead>
<tbody>
<tr>
<td>The owner/operator of the application block has been informed that he/she as well as the certified applicator must keep a signed copy of the site-specific FMP and the post-application summary for 2 years from the date of application.</td>
</tr>
</tbody>
</table>

| V. General Application Information |
|---|---|---|
| Target application date/window: | EPA Registration Number: | Fumigant Product Name: |

<table>
<thead>
<tr>
<th>Application method:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarp bedded</td>
</tr>
<tr>
<td>Tarp broadcast</td>
</tr>
<tr>
<td>Deep untarp broadcast (CA only)</td>
</tr>
<tr>
<td>Hot gas – outdoor</td>
</tr>
<tr>
<td>Hot gas – greenhouse</td>
</tr>
<tr>
<td>Hand held probes (tree hole)</td>
</tr>
</tbody>
</table>

| Application Rate (lbs or gallons of product/treated acre): | Injection Depth (inches): | Application Block Size (acres): |

<table>
<thead>
<tr>
<th>VI. Emergency Response Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of evacuation routes (a diagram or drawing may be attached to the FMP):</td>
</tr>
<tr>
<td>Check here if diagram or drawing is attached</td>
</tr>
</tbody>
</table>

| Locations of telephones: |

| Contact information for first responders: | Local/state/federal contacts: | Other contact information for emergencies: |

| Emergency procedures/responsibilities in case of an incident, equipment/tarp/seal failure, complaints or elevated air concentration levels suggesting potential problems, or other emergencies: |
Key
Phase 2 Measures

Key Measures
Second Phase of Implementation - late 2011

- Buffer zones
- Site-specific response measures (if triggered)
- Buffer zone monitoring or
- Response information for neighbors
- FMPs with additional elements
Buffer Zone Calculator
(sample screen)

EPA reg number: 11220-10
Product name: Tri-Con 50/50
Company name: Trical
Active ingredients:
methyl bromide - 50%
chloropicrin - 49.5%
Application method:
- Tarped bedded
- Tarped broadcast
- Deep untarped
- Outdoor tarped hot gas
- Greenhouse tarped hot gas
- Tree hole replacement with hand held probe
Note: User must verify that the application methods selected are allowed by product label.
Soil moisture:
- Soil moisture is $\geq$ 70% and measured with instrument or $\geq$75% using the USDA Feel and Appearance Method
- Soil moisture is 50 to 69% and measured with instrument or 50 to 75% using the USDA Feel and Appearance Method

<-- Return To Welcome Screen  Continue to Application Inputs
Outreach Materials

EPA materials for outreach include

- Fact sheets
- Presentations and training modules
- Tools and templates

Visit . . .

www.epa.gov/oppsrrd1/reregistration/soil_fumigants

Or internet search for . . .

“soil fumigant implementation”
Changes to California’s Methyl Bromide Regulations

Summary:

• County Ag Commissioners may not use buffers smaller than specified in the “MB Field Fumigation Buffer Zone Determination” document

• Respirator type clarified

• Revised MB monthly township caps – 171,625 lbs per month

• Revised maximum work hours in a 24-hour period – Most reduced by 1 hour
Summary:

• CDPR is currently developing the risk assessment for 1,3-dichloropropene
• Completed risk assessment expected in 2011
• Based on results, CDPR may propose additional mitigation to address any risk concerns identified
In San Joaquin Valley additional restrictions may apply

May affect applications taking place May 1 – October 1

County Agricultural Commissioners will be able to provide specific information
General Contact:
• John Leahy (703) 305-6703

Team Leaders:
• Steven Weiss (703) 308-8293
• Cathryn O’Connell (703) 308-0136
• Eric Olson (703) 308-8067

E-mail: lastname.firstname@epa.gov
Thank You
Wrap-Up, Discussion and Q&A
Next Session:

Treevix Herbicide, a new Innovation in Broadleaf Weed Control in Almonds from BASF
Treevix Herbicide from BASF

Ben Duesterhaus, BASF