Southern California update on soil disinfection methods
What’s in our soils

Documented fields during last 8 years with:

- *Fusarium oxysporum*: 16
- *Macrophomina phaseolina*: 11
- *Verticillium dahliae*: 5
- *Phytophthora fragariae*: 3

Undocumented: 30%? 60%? 100%?

- ‘Minor’ pathogens:
  cause 10-50% reduction in yield when soil is untreated
- Yellow nutsedge: 25-30% of fields

In both: winter and summer strawberries
CONVENTIONAL PRODUCTION

FUMIGATION COSTS:
Flat fumigation = $3,000-3,700/Acre
Drip (bed) fumigation = $1,200-1,800/Acre (>70% of all fumigated acres)
Fusarium oxysporum

No significant effect of depth: 0-6” = 6-12”

Pic, 300 lbs/a, flat

Untreated
Effect of location in bed on fumigant efficacy

DRIP-FUMIGATED with Piclor 60, 300lbs/a

Fusarium: Spores per gram of soil

Location in bed

- 6” depth
- 12” depth
2015 Oxnard trial
with Tri-Clor EC:
full rate: 200 lbs/ac
half rate: 100 lbs/ac
FUSARIUM survivorship

Four drip tapes at 2.5” depth:

- 6” depth
- 12” depth

Spores per gram of soil

Not detectable

Location in bed:

Center

Shoulder
FUSARIUM survivorship: two shallow (2.5”) + two deep (7”)

Four drip tapes:
- 6” depth
- 12” depth

Spores per gram of soil:
- Center
- Shoulder

Location in bed

Not detectable
Fusarium in sand inoculum

- TIF Full 2 Lines
  - 0-6"
  - 6-12"

- TIF Full 4 Lines (shallow)

\[ a > b, \text{P}=0.01 \]
Plant mortality (due to Fusarium)

'1975'

'San Andreas'

TIF Non-fumigated
PE Full 2 Lines
TIF Full 2 Lines
TIF 1/2 rate 4 Lines (2 shallow + 2 deep)
TIF Full 4 Lines (shallow)
TIF 1/2 rate 4 Lines (shallow)
TIF Full 4 Lines (2 shallow + 2 deep)
‘Fronteras’ is resistant to _F. oxysporum_?!
What else can we do?

• Removal or destruction of infested crowns
• Precision fumigation/or other management based on need
• Using low-cost MITC generators as only pre-plant fumigants
• Getting new varieties with genetic resistance/tolerance
Mortality and rates

S = Standard
P = Precision

Rate Zones:
- High
- Medium
- Low
Plant early vigor after flat Pic

Canopy area, cm²

250 lbs/A

300 lbs/A

350 lbs/A
Can we sustain production

1. Vapam, single application of 58 gal/A
2. Vapam (58) 1b Vapam (36) split application and
3. Vapam (36) after flat Pic (300) application
Plant early vigor

Canopy area, cm²

- Vapam 58 gal/A
- Vpam 58 fb Vapam 36
- Pic (300, flat) fb Vapam (36)

Annotations:
- a
- b
- ab
ORGANIC PRODUCTION
organic field with *M. phaseolina*: Sabrina vs Ventana
ASD = Carbon source + water + plastic

With RICE BRAN ~$2,800-3,000/A
Adding rice bran to soil for ASD

- Anaerobiosis
  - Organic acids
  - pH reduction
  - Micronutrient availability
- Available Nitrogen
- Infiltration and salt leaching
- Available Phosphorus
- Microbial population shifts
- Interaction with pathogenic organisms?

Short vs long term? Other C-sources and soil environments?
For C-source:

- Rice bran
- Glycerin
- Grape pomace
- Molasses
- Coffee grounds
- Grass clippings
- Spent grain
- And other

- Favorable C/N
- Easy to apply
- Cheap or Free and Available
- Min.Transportation
- Works consistently
Grapple grapple nice brain and blend (nice almond mix) in organic field.
Marketable fruit yield, Dec-March

Treatments with the same letter are not significantly different at P=0.05.
### ASD C-sources:
 favorable C/N ratio, local, available, cheap

<table>
<thead>
<tr>
<th>Coffee grounds</th>
<th>Spent grain</th>
<th>Grass clippings</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Coffee grounds" /></td>
<td><img src="image2.png" alt="Spent grain" /></td>
<td><img src="image3.png" alt="Grass clippings" /></td>
</tr>
</tbody>
</table>
Anaerobic conditions in clay loam soil (9 t dry weight /acre)

Soil Eh changes (Hansen trial 2015. 6” depth)
2015-16: NO$_3$-N at 0 -12″

Untreated check beds received 500 lbs/A of 18-6-8 pre-plant
2015-16

Marketable yield Dec-March

- Beer waste: +51%
- Coffee grounds: +83%
- Grass clippings: +47%
- Untreated

Note: Different letters (a, b) indicate significant differences among treatments.
2016-17
Roasting facility for Starbucks = coffee grounds

- < 15 miles from application sites
- Free + free delivery
- 15-20 cu yards available weekly
- Can be stored at field site
- Easy to apply
ANAEROBABIC CONDITIONS

Soil Eh (mV)

- 81% WEED CONTROL

Soil Eh (mV) vs. Treatment period (days)
NO$_3$-N at 0-12"

Untreated check beds in 2015 received 500 lbs/A of 18-6-8 pre-plant
<table>
<thead>
<tr>
<th></th>
<th>Peet’s</th>
<th>Starbucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N, %</td>
<td>2.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Total C, %</td>
<td>54.1</td>
<td>22</td>
</tr>
<tr>
<td>C:N ratio</td>
<td>22:1</td>
<td>24:1</td>
</tr>
<tr>
<td>Total P₂O₅, %</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Total K₂O, %</td>
<td>0.26</td>
<td>0.23</td>
</tr>
<tr>
<td>EC, dS/m</td>
<td>3.5</td>
<td>3.1</td>
</tr>
<tr>
<td>pH</td>
<td>6.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Ash %</td>
<td>2.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Moisture%</td>
<td>63</td>
<td>24</td>
</tr>
</tbody>
</table>
ASD-COFFEE

• In spring plants started to grow more rapidly and were not different than untreated plants (too late for fresh market)
• At another location Coffee-ASD plots had 52% fewer dead plants with *M. phaseolina* in May 2017.
Horseweed (Coryza app.) weed number/100ft of post row on Feb 12, 2013
Seedbank weeds (little mallow, flax, shepardspurse) number/100ft of post row on Feb 12, 2017.
Untreated (standard)

Barley cover crop
planted at 500lbs/A,
terminated at heading
with sethoxydim and
mowing, as needed

Yardwaste mulch
(1-4 inch particles)
applied 2-3 inches thick
**Weed barrier**
fabric placed on soil surface and pinned

**Polyacrylamide**
(PAM, ‘Simplot Soilbuilder’)
applied at ~2lbs/A before rain events
<table>
<thead>
<tr>
<th>TREATMENTS</th>
<th>Turbidity in Runoff</th>
<th>Nitrogen and phosphorus</th>
<th>Weed control/density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>355 to 614 nephelometric turbidity units</td>
<td>N\text{NO}_3 + N\text{NO}_2 : ranged from 0.25 to 1.75 mg/L.&lt;br&gt;Total P: ranged from 0.23 to 1.2 mg/L</td>
<td>All species (annual sowthistle, little mallow and common groundsel) were 206 and 651 plants/1750ft² post row area</td>
</tr>
<tr>
<td>Barley cover crop</td>
<td>Reduced 40-59%</td>
<td>N\text{NO}_3 + N\text{NO}_2 : Reduced (48%) only during 1 out of 6 rain events.&lt;br&gt;Total P: reduced 34-50%</td>
<td>Reduced 87% in Nov 2016, but only 48% in Feb. 2017 when barley straw mulch deteriorated.</td>
</tr>
<tr>
<td>Weed barrier</td>
<td>Reduced 55-85%</td>
<td>N\text{NO}_3 + N\text{NO}_2 : No reduction&lt;br&gt;Total P: reduced 35-61%</td>
<td>Reduced 98%</td>
</tr>
<tr>
<td>Yardwaste mulch</td>
<td>Reduced 74-94%</td>
<td>N\text{NO}_3 + N\text{NO}_2 : No reduction&lt;br&gt;Total P: Increased 22%</td>
<td>Reduced 80-90%</td>
</tr>
<tr>
<td>PAM</td>
<td>Reduced 88% when applied before rain.&lt;br&gt;When soil disturbed after application, turbidity was similar to Untreated.</td>
<td>N\text{NO}_3 + N\text{NO}_2 : No reduction&lt;br&gt;Total P: Reduced 47-48%</td>
<td>NO effect on weeds</td>
</tr>
</tbody>
</table>
- Pencimethalin (Prowl + 1-2%) in raspberries
- Can be applied to post-emergence in season
- Effective and non-injurious in transplanted lettuce

Prowl 4.2 pints/A

Untreated
Root zone injury or stuntting from saturation of...
2.4-D injury

Young shoots

2 ft tall cane
Acknowledgements

• Matt Conroy and Dave Murray (Andrew and Williamson fresh produce)
• Hector Gutierrez (Otillo Farms)
• Henry Ito (Ito Bros.)