What else can we do with drip fumigation?

Oleg Daugovish, Anna Howell, Bill Rutan, Steve Koike (UC- ANR), Tom Gordon and Ruijun Qin (UC –Davis), Suduan Gao and Jim Gerik (USDA)
End of the season Vapam via drip 50 gal/acre
Yellow nutsedge shoots / 4 tubers

UNTRETED CHECK: 80-100% germination

Drip lines

6 in

3.2 3.5

12 in

3.2 4
Yellow nutsedge shoots / 4 tubers

VAPAM: 0 to 33% germination
Depth was not important but location was:

After VAPAM in
PLANT ROWS

After VAPAM under the
DRIP LINES
What about Fusarium?
F. oxysporum in sand inoculum

The diagram shows the CFU/g sand for Vapam 50 gal and Untreated samples. The treatments include:
- Under tape 6"
- Under tape 12"
- Under plant row 6"
- Under plant row 12"

The asterisk (*) indicates a statistically significant difference.
Recovery of *F. oxysporum* from infested crowns

- **Vapam 50 gal**
  - Under tape 6"
  - Under tape 12"
  - Under plant row 6"
  - Under plant row 12"

- **Untreated**
  - Under tape 6"
  - Under tape 12"
  - Under plant row 6"
  - Under plant row 12"

* indicates a significant difference.
Pathogen Survival at depths 12” +

DRIP-FUMIGATED with Piclor 60, 300lbs/a

Fusarium: Spores per gram of soil

Location in bed

- Center
- Shoulder
- Under tape

6” depth
12” depth
At what depth do roots become infected?

In an infested buffer zone we replaced soil with fumigated soil: 0-6”, 0-12” 0-16”
Planted in replaced fumigated soil 0-16”

April 16, 2013
Planted in replaced fumigated soil 0-6”

April 16, 2013
Replacement of soil in infested buffer zone with fumigated soil to 3 depths. May 5, 2013

**Mortality, %**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Mortality, %</th>
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<tbody>
<tr>
<td>0-6&quot;</td>
<td>70</td>
</tr>
<tr>
<td>0-12&quot;</td>
<td>30</td>
</tr>
<tr>
<td>0-16&quot;</td>
<td>20</td>
</tr>
</tbody>
</table>

**Infection rate, 1-5 (1=healthy, 5=dead)**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Infection Rate (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6&quot;</td>
<td>4.5</td>
</tr>
<tr>
<td>0-12&quot;</td>
<td>2.5</td>
</tr>
<tr>
<td>0-16&quot;</td>
<td>1.5</td>
</tr>
</tbody>
</table>
CAN WE FUMIGATE DEEPER WITH 2 additional ‘deep’ drip lines?
Treatments

1) Untreated - 2 lines under TIF w/o fumigation
2) Two shallow drip lines – full rate under PE
3) Two shallow drip lines - full rate under TIF
4) Two shallow drip lines - 1/2 rate under TIF
5) Four drip lines (2 shallow & 2 deep) - full rate under TIF
6) Four drip lines (2 shallow & 2 deep) - 1/2 rate under TIF

Pic-Clor 60 EC 300 lbs/ac vs. 150 lbs/ac (1/2 rate); a mixture of 56.7% CP, 37.1% 1,3-D, and 6.2% inert.
Measurements

• During fumigation period (Aug. 16-Aug. 30):
  – Emission (passive chamber): Full rate TIF treatments (bed and furrow).
  – Fumigant concentration under film above soil surface (AU).
  – Fumigant gas in soil profile.
  – Pathogen survival at the end of fumigation.

• After fumigation:
  – Plant performance and fruit yield
Fumigant emissions from bed

Deep vs. shallow application:

![Graphs showing emission flux vs. fumigation time for 1,3-D and CP]

- **1,3-D**
  - Deep (blue circles)
  - Shallow (red squares)

- **CP**
  - Deep (blue circles)
  - Shallow (red squares)
Fumigant emission from furrow

Deep- vs. shallow-application:

**1,3-D**

- **Deep**
- **Shallow**

![Graph 1](image1)

**CP**

- **Deep**
- **Shallow**

![Graph 2](image2)
Fumigant concentration under film
Fumigant concentration time exposure index

**TIF/deep/full**

**TIF/shallow/full**
Marketable fruit yield

January 30 to March 18.

+ 15%  
+ 10%

2 lines - full rate  
2 lines - half rate  
4 lines full - rate  
4 lines - half rate  
untreated

g/20 plants in first 8 harvests
Questions on deep fumigation technique

– What’s the best application depth?
– How to improve fumigant distribution at bed center?
– How to remove deep-buried tape at the end?
Fumigation via 4 ‘shallow’ drip lines

Nutsedge tubers and Pathogens inoculum
Yellow nutsedge shoots after 150 lb Pic with various applications
What else can we do with Anaerobic Soil Disinfestation?

Oleg Daugovish, Anna Howell, Bill Rutan, Steve Koike (UC-ANR), Joji Muramoto and Carol Shennan (UCSC)
Effective ASD = C-source + water + plastic mulch

- Need C-source uniformly mixed
- Standard LDPE mulch – sufficient
- Black mulch as good as clear
- 3 inches of water - sufficient
- 3 weeks duration in summer
For C-source:

- Rice bran applied to beds: at least 25% less needed
- Apply Glycerin at 4% by volume via drip

For water:

- Delay drip irrigation 1 wk after bedding
- Apply no water after bedding
- Drip-irrigate immediately
Anaerobic conditions

Soil Eh changes
(Hansen trial 2014. 6" depth)
Anaerobic conditions

Cumulative Eh mV hrs (Hansen trial 2014)
No effective herbicides for nutsedge control in strawberry?

Oleg Daugovish, Anna Howell, Bill Rutan, UCCE-Ventura and Steve Fennimore and Tom Gordon, UC-Davis.
No effective fumigants after MB and MI are out
S-metolachlor (Dual Magnum)

- Good nutsedge efficacy and safety in vegetable crops
- Added to IR-4 (minor crop) list for strawberry:
  Supporting data on nutsedge control in strawberry and crop safety
Yellow and purple nutsedge at Santa Paula, CA in summer-planted strawberry, 2009

• Nutsedge tubers placed in pots into beds
• DM 0.95 lb a. i. /acre on June 9
• Applied to beds and covered by mulch
• Strawberry transplanted 30 d later
Purple nutsedge

Untreated control

DM 0.95lb a. i./acre
Purple nutsedge counts

No significant injury to strawberry


shoots/pot

Dual Magnum, 0.95

Untreated

No significant injury to strawberry
Yellow nutsedge counts

Injury was not determined: poor quality transplants
March 19, 2010: yellow nutsedge re-emergence in untreated

DM 0.95

Untreated
2010:
Nov 22
DM 0.63  DM 0.95  Untreated
2010

Injury (1=none to 10 =dead)

Mortality: identical in all treatments ~1.5%
Marketable fruit yield, 2011

Unmarketable yield: similar trend
2013:
Look at lower rates

Untreated
DM 0.33
DM 0.48
DM 0.63
Yellow nutsedge shoots

# shoots/plot

Untreated   DM 0.33   DM 0.48   DM 0.63
Mortality: identical in all treatments <2%

Injury (0=none to 10 =dead)

Untreated DM 0.33 DM 0.48 DM 0.63

NO SIGNIFICANT DIFFERENCES

Mortality: identical in all treatments <2%
Fruit yield (first 4 harvests)

NO SIGNIFICANT DIFFERENCES
S-metolachlor (Dual Magnum)

- Use pattern: 30 d pre-plant to bed tops; Similar to our current herbicides and can be tank mixed
- Petition submitted to EPA in Feb 2014.
- 30 d pre-harvest if applied to furrows
- Supplemental indemnified 24 C label (SLN), registrant expects 2015
S-metolachlor (Dual Magnum): rates

<table>
<thead>
<tr>
<th>Application Timing</th>
<th>Crop Growth Stage</th>
<th>Rate (pt/A)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preplant³</td>
<td>Before transplanting</td>
<td>0.67 - 1.33 (0.64-1.27 lb ai/A)</td>
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</table>
Acknowledgements

• Will Doyle with DW Berry Farms, Steve Imoto with Solimar Farms and UC Hansen
Feb 3-6 in Ventura:

- > 60 presentations on all strawberry topics
- 6-7 workshops/roundtables
- Tour of production and research
- US and International speakers
- Info and registration at: website: http://www.nasga.org