ADDRESSING PRACTICAL LIMITATIONS TO
THE ADOPTION OF ANAEROBIC SOIL
DISINFESTATION

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Anaerobic Soil Disinfestation (ASD)

Composted Broiler Litter 28 Mg ha\(^{-1}\)

Amendments are worked in

Molasses 20 Mg ha\(^{-1}\)

Cover and H\(_2\)O 200 cubic meter

* Butler et al., 2012. Crop Protection 39:33-40
Efficacy Established

- Key soil-borne pathogens and weeds
  - Phytophthora blight
    - (Phytophthora capsici)
  - Fusarium wilts (Fusarium oxysporum)
  - Southern blight (Sclerotium rolfsii)
  - Charcoal Rot (Macrophomina phaseolina)
  - Root-knot nematodes (Meloidogyne spp.)
  - Yellow and purple nutsedges (Cyperus spp.)
Obstacles

- Solarization “Requirement”
  - Plastic Testing
  - Herbicides
- Carbon Inputs
  - Temperature-Spring
- ASD and Broiler Litter
  - Salmonella Testing
  - Alternative Nitrogen Inputs
- Economics
- Nitrogen Management
  - Nitrate leaching and GHG emissions
Previous work assumed the need for combining with solarization for heavy weed issues—requires two plastic laying events.
Solarization

- Daily maximum temperatures at 15-cm depth
  - ~45°C (115°F) with solarization
  - < 33°C (~90°F) under reflective silver plastics

(Butler et al., unpublished)
Impact of Plastics on Weed Control

Nutsedge

<table>
<thead>
<tr>
<th></th>
<th>Preplant</th>
<th>Plastic</th>
<th>Hole</th>
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<tbody>
<tr>
<td>Ginegar CL</td>
<td>A</td>
<td>ab</td>
<td>A</td>
</tr>
<tr>
<td>TIF CL</td>
<td>a</td>
<td>b</td>
<td>A</td>
</tr>
<tr>
<td>HDPE WT</td>
<td>b</td>
<td>ab</td>
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<td>ab</td>
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<tr>
<td>TIF WT</td>
<td>a</td>
<td>b</td>
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</tr>
</tbody>
</table>
To solarize or not to solarize…

![Bar chart showing cumulative eh (mV hours) for various samples: SOL, SOL/H2O, SOL/ASD, SOL/ASD/CHT, TIF, TIF/H2O, TIF/ASD, TIF/ASD/CHT, TIF/ASD/CHT/H2O. The y-axis represents cumulative eh in mV hours, and the x-axis lists the samples. The bar heights indicate the cumulative eh values for each sample.]
Mid-Season Bell Pepper Mortality

Plant Mortality

- SOL
- SOL/H2O
- SOL/ASD
- SOL/ASD/CHTN
- SOL/ASD/CH/H2O
- TIF
- TIF/H2O
- TIF/ASD
- TIF/ASD/CHTN
- TIF/ASD/CHTN/H2O

Mortality levels:
- C
- BC
- ABC
- A

(Note: The exact plant mortality values for each condition are not specified in the image.)
Plastic Summary-TIF

- Improves Weed Control
- Increases Anaerobicity
- No change in nematode control
- Solarization is a better option for Phytophthora capsici, possibly other oomycetes
ASD and CBL concern

- Composted Broiler Litter
  - Salmonella testing
    - Effective composting
      - (Guan et al., 2006. Poultry Science 86:610-613.; review Chen and Jiang, 2014. Agriculture 4:1-29)
    - Serological and Molecular Techniques
      - Enrichment, selective plating, PCR with genus-specific primers
      - CBL, soil pre and post, and green and red tomato fruit

No evidence of Salmonella, but other potential human pathogens were not tested.
Inputs and Anaerobicity

Alternative Nitrogen Inputs

1) “standard” ASD-CBL, 2”, molasses
2) Chitin/CBL (ROOTGUARD®)ASD
3) Pelleted litter (MicroSTART60)ASD
4) Mustard (MustGro™)
5) Soybean meal ASD
6) Corn gluten ASD
7) Mustard alone
8) Algal compost
9) Untreated-irrigation only

All solarized, all with irrigation
Alternative N inputs

UTC-solarization, water, and fertigation
All treatments “balanced for N”
Cummulative Anaerobicity*-1 week

UTC ASD2 soy meal corn gluten algae ASD1

Eh (mV)
Temperature and Carbon Rate

- Pathogens/nematodes
  - *Fusarium oxysporum*
  - Southern root-knot nematode
- Soil temperatures
  - 15 C to 25 C
  - 25 C to 35 C
  - 35 C to 45 C
- C-source treatments
  - 0 mg C g$^{-1}$ soil
  - 1 mg C g$^{-1}$ soil
  - 2 mg C g$^{-1}$ soil
  - 3 mg C g$^{-1}$ soil
  - 4 mg C g$^{-1}$ soil
- Mixtures of starch and glucose
Cumulative Anaerobicity

<table>
<thead>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>Overall Averages</th>
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<td>25.5</td>
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<td>25.7</td>
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<td>11</td>
<td>18</td>
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<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>25.9</td>
</tr>
</tbody>
</table>

1 = 34 hrs over 35°C
2 = 25.5 hrs
3 = 24.9 hrs

Overall averages:
1 = 25.7
2 = 25.3
3 = 25.9
Tomato Total Marketable Yield

<table>
<thead>
<tr>
<th></th>
<th>PicClor</th>
<th>ASD1</th>
<th>ASD2</th>
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<tbody>
<tr>
<td>Mg/ha</td>
<td>A</td>
<td>B</td>
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<tr>
<td>Immok</td>
<td>40</td>
<td>60</td>
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<tr>
<td>Citra</td>
<td>10</td>
<td>15</td>
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</tr>
</tbody>
</table>

Legend:
- Immok
- Citra
Nutsedge Survival - 80 days

- PicClor: A
- ASD1: B
- ASD2: B

#/sq m

- Immok
- Citra
Currently-Addressing Weed Control and Input Reductions
0.5x CBL, Agricultural Carbon Source (molasses), Sandea

Half-rate ASD under TIF
Alternative organic inputs have potential-rates?
Initial evidence that herbicides can be used with ASD
Can cut the rate of carbon in the fall
Not everything is correlated with level of anaerobicity
ASD: Mechanisms

- Accumulation of toxic products from anaerobic decomposition (e.g. organic acids, volatiles)
- Biological control by facultative anaerobic microorganisms
- Low pH
- Lack of oxygen
- Combination of all of these
- Addressing Variability
Laboratory: Molecular Tools

- DNA Extraction
- Primers
  - Specific
  - 16s rRNA
- Length Heterogeneity PCR
- Next Generation Sequencing
Significant shifts in microbial communities

Non-metric multi-dimensional scaling (MDS) plot derived from SIMPR values comparing the similarity of the resulting bacterial populations from soil samples taken from six fields treated with anaerobic soil disinfestation (ASD) detected by length heterogeneity pcr. (LH-pcr).
Changes in Dominance
Next Generation Sequencing
ASD: Mechanisms

- 445 population in inputs
Limitations

- Logistics-Scale
- Economics
A no-litter system - ASD-specific “pro-biotics”?
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