Soil health and temperature management in high tunnel vegetable production

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High tunnel: great resource

- 4-5 week earlier production in the Spring
- Extended fall production
- Better control on crop growth
- Enhanced fruit quality
- Disease control
Oxymoron = Figure of speech that combines contradictory terms

High tunnel is like an irrigated desert

Challenges exist!

- Soil management
- Pest management
- Temperature management
How cover crops could help

- Nutrient management
- Soil Microorganisms
- Soil health
- Pest and Diseases
- Organic matter
- Biodiversity
- Crop rotation
- Fruit and Vegetable Production

Cover cropping window: High Tunnels

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Brassica cover crop study

**TREATMENTS**

1. Yellow Mustard (10lb/A)
2. Oilseed radish (10lb/A)
3. Control (no cover crop)

Seeding on 6th March, 2012

7th May, 2012
Chop and then incorporate Brassica cover crops as Biofumigants.
Cover Crop biomass

![Bar graph showing dry weight biomass of Oilseed radish and Yellow Mustard.](image)

- **Oilseed radish**: b
- **Yellow Mustard**: a

**Dry weight (lb/A)**

**Control plots (no cover crop)**

**High Weed pressure**
Very low weed pressure

Weed biomass

![Graph showing weed biomass](image)

- Oilseed radish
- Yellow Mustard
- Control

- **Weed dry weight (lb/A)**
  - 0
  - 500
  - 1000
  - 1500
  - 2000
  - 2500

- **Legend:**
  - a
  - b
  - b
### Effect on soil pH

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Before CC seeding</th>
<th>Mid-season</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7.1</td>
<td>7.1</td>
<td>6.9</td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>6.6</td>
<td>7.1</td>
<td>6.7</td>
</tr>
<tr>
<td>Yellow Mustard</td>
<td>6.7</td>
<td>6.8</td>
<td>6.8</td>
</tr>
</tbody>
</table>

### Effect on soil Electrolytic conductivity (dS/m)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Before CC seeding</th>
<th>Mid-season</th>
<th>Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.2b</td>
<td>0.2a</td>
<td>0.2b</td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>0.3b</td>
<td>0.2a</td>
<td>0.4a</td>
</tr>
<tr>
<td>Yellow Mustard</td>
<td>0.6a</td>
<td>0.2a</td>
<td>0.3ab</td>
</tr>
</tbody>
</table>
## Effect of cover crop on tomato yield

### 2012

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Marketable number</th>
<th>Marketable weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>166</td>
<td>29</td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>165</td>
<td>29</td>
</tr>
<tr>
<td>Yellow Mustard</td>
<td>166</td>
<td>31</td>
</tr>
</tbody>
</table>

Data reported from 10 plants/treatment

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## Effect of cover crop on tomato yield

### 2013

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Marketable number</th>
<th>Marketable weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>125</td>
<td>23</td>
</tr>
<tr>
<td>Oilseed Radish</td>
<td>123</td>
<td>23</td>
</tr>
<tr>
<td>Yellow Mustard</td>
<td>109</td>
<td>20</td>
</tr>
</tbody>
</table>

Data reported from 10 plants/treatment
Root zone temperature management

• High tunnel tomato production
• Plastic mulch impact on root growth and development, crop yield, and productivity

Temperature management

• Above ground
• Below ground
• Temperatures can get as high as 120F
• Need to reduce plant stress
As humans we are so much in love with COLORS!
Which COLOR do most people like in the world?
Plastic mulch

- Earliness
- Weed control
- High yield and quality
- Efficient water use
- Disease control
- Insect control (aphids)
- Optimal fertilizer use
- Reduce fertilizer leaching

Earliness

- 7 to 14 days and up to 21 days early than bare ground treatment
- Depends on geographic location, soil type, and type of plastic mulch
Plastic mulch classification

- Conventional (black and other colors)
- Highly reflective
- Photoselective
- Photodegradable
- Biodegradable

Colored Plastic mulch

White
Black
Black/White
Gray
Green
Brown
Blue
Red
**Black Plastic Mulch**

- The most widely used, available, and inexpensive
- Excellent weed control
- Soil underneath black plastic mulch usually 5 °F warmer at a 2-inch depth and up to 3 °F warmer at a 4-inch depth than uncovered soil at the same depths

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**General Specification**

- 1 to 1.25-mil thickness
- 3 to 5 ft wide and come on rolls 2400 to 4000 feet long rolls.
- Either smooth or embossed with a diamond-shaped pattern that helps reduce expansion and contraction

$$\text{100/2400 ft long}$$
White

- Less attractive for us in the northern climate
- Weed suppression and soil warming to a lesser degree
- Good for cool season crops such as cauliflower, lettuce, broccoli, cabbage

Blue

- Decent weed suppression
- Cucurbit crops have traditionally shown better response but tomatoes also benefit
**Silver**

- Deter aphids and whiteflies
- Suppress viral and bacterial disease spread
- Cucumber beetle control reported
- Pepper has shown good response

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**RED**

- Similar properties like black plastic mulch
- Has shown promise in tomato production (15-20% higher yields)
- Increased yields in zucchini, honeydews, and muskmelons
IRT’s

- Infra-Red Transmitting
- Combination of clear and black plastic
- Soil temperatures typically fall between the ranges of black and clear plastic
- Crops grown on IRT mulch usually develop 7 to 10 days earlier than crops grown on black plastic
- IRT mulches are typically translucent green or brown
### Effect on tomato yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Marketable</th>
<th>Non-marketable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>Yield&lt;sup&gt;NS&lt;/sup&gt; (kg)</td>
</tr>
<tr>
<td>Bare ground</td>
<td>176</td>
<td>38.5</td>
</tr>
<tr>
<td>Black plastic</td>
<td>180</td>
<td>41.3</td>
</tr>
<tr>
<td><strong>Blue plastic</strong></td>
<td>197</td>
<td>46.7</td>
</tr>
<tr>
<td>Olive plastic</td>
<td>186</td>
<td>41.8</td>
</tr>
<tr>
<td>Red plastic</td>
<td>176</td>
<td>38.0</td>
</tr>
</tbody>
</table>

* Data collected from 10 plants harvested six times during the growing season

<sup>NS</sup> Non-significant; Fisher’s Protected LSD (P ≤ 0.05)
## Plant growth characteristics

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height&lt;sup&gt;NS&lt;/sup&gt; (cm)</th>
<th>SPAD&lt;sup&gt;NS&lt;/sup&gt;</th>
<th>Stem girth&lt;sup&gt;NS&lt;/sup&gt; (mm)</th>
<th>Plant dry weight&lt;sup&gt;NS&lt;/sup&gt; (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare ground</td>
<td>83.4</td>
<td>55.5</td>
<td>12.7</td>
<td>380.0</td>
</tr>
<tr>
<td>Black plastic</td>
<td>88.6</td>
<td>58.0</td>
<td>13.3</td>
<td>420.0</td>
</tr>
<tr>
<td>Blue plastic</td>
<td>87.7</td>
<td>58.8</td>
<td>13.8</td>
<td>463.3</td>
</tr>
<tr>
<td>Olive plastic</td>
<td>82.4</td>
<td>58.3</td>
<td>14.4</td>
<td>606.7</td>
</tr>
<tr>
<td>Red plastic</td>
<td>86.1</td>
<td>59.5</td>
<td>14.1</td>
<td>466.7</td>
</tr>
</tbody>
</table>

<sup>*</sup> Means for plant height, SPAD, and stem girth are average of measurements from six plants per treatment replication taken on 28 June, 2012. Plant dry weight is average of data collected from two whole plants collected after the final harvest on 20 August, 2012.

<sup>NS</sup> Non-significant; Fisher’s Protected LSD (P ≤ 0.05)

## Fruit characteristics

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH&lt;sup&gt;NS&lt;/sup&gt;</th>
<th>EC&lt;sup&gt;NS&lt;/sup&gt; (dS/m)</th>
<th>TSS&lt;sup&gt;NS&lt;/sup&gt; (Brix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare ground</td>
<td>4.4</td>
<td>3.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Black plastic</td>
<td>4.4</td>
<td>3.0</td>
<td>5.1</td>
</tr>
<tr>
<td>Blue plastic</td>
<td>4.5</td>
<td>3.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Olive plastic</td>
<td>4.4</td>
<td>2.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Red plastic</td>
<td>4.5</td>
<td>2.6</td>
<td>5.2</td>
</tr>
</tbody>
</table>

<sup>*</sup> Data from four marketable fruits collected randomly from each treatment replication on 7 August, 2012.

<sup>NS</sup> Non-significant; Fisher’s Protected LSD (P ≤ 0.05)
### Soil temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare soil</td>
<td>25.0</td>
</tr>
<tr>
<td>Black</td>
<td>26.0</td>
</tr>
<tr>
<td>Blue</td>
<td>25.0</td>
</tr>
<tr>
<td>Olive</td>
<td>24.9</td>
</tr>
<tr>
<td>Red</td>
<td>25.3</td>
</tr>
</tbody>
</table>

### Mulch Color, Benefits & Best crops

<table>
<thead>
<tr>
<th>Mulch Color</th>
<th>Benefits</th>
<th>Best crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Increase soil temperature</td>
<td>Potato, onion</td>
</tr>
<tr>
<td>Blue</td>
<td>Increase soil temperature, change light quality</td>
<td>Cucumber, summer squash, cantaloupe</td>
</tr>
<tr>
<td>Red</td>
<td>Increase soil temperature, change light quality</td>
<td>Eggplant, tomato, onion, potato</td>
</tr>
<tr>
<td>Yellow</td>
<td>Attracts insects</td>
<td>Basil</td>
</tr>
<tr>
<td>White</td>
<td>Decrease soil temperature</td>
<td>Lettuce</td>
</tr>
<tr>
<td>Aluminum Reflective</td>
<td>Decrease soil temperature, deters insects</td>
<td>Pepper, onion and potato</td>
</tr>
<tr>
<td>Clear</td>
<td>Highest soil warming capacity</td>
<td>Sweet corn</td>
</tr>
</tbody>
</table>

*(Source: Penn State Center for Plasticulture)*
Many Thanks

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http://iowavegetables.blogspot.com
www.extension.iastate.edu/vegetablelab
Questions?

Are you ready for this?