Disease Control in High Tunnels

Fulya Baysal-Gurel
Sally A. Miller
Department of Plant Pathology
Damping-Off

- Caused by various fungi, including *Pythium*, *Rhizoctonia*, *Fusarium* spp.
- Favored by over-watering, excessively high or low temperatures
Diseases Caused by *Rhizoctonia*

- *R. solani*
- Wide host range includes crucifers, bean, beets, spinach, tomato
- Aerial blight/root/crown rot of tomato in 2013
Pythium Root Rot

- *Pythium aphanidermatum, P. ultimum, etc.*
- Favored by wet soils
Diseases Caused by *Sclerotinia*

**White mold**
Beans, Cabbage, Pepper, Tomato, Eggplant, Cucurbits, Carrots etc.
*S. sclerotiorum*

**Drop**
Lettuce
*S. minor, S. sclerotiorum*
Powdery Mildew

• Favored by high relative humidity, warm temperatures

• Free moisture on the plant surface inhibits the pathogen’s growth

• High fertility and succulent plant growth favor the disease
Diseases caused by *Botrytis*

- Wide host range
- Grey mold, blast, blight
- Easily sporulates on plant tissue
Leaf Mold

Passalora fulva

Black Leaf Mold of Tomato Caused by Pseudocercospora fuligina
Late Blight - *Phytophthora infestans*

- Favored by cool, wet conditions
- All above-ground parts of the plant are susceptible: lesions are brown-black
- Disease can progress very quickly
- Early sources of the pathogen:
  - Transplants (tomatoes)
  - Tubers and volunteers (potatoes)
Diseases Caused by Bacteria

- Most (except soft rots) are seedborne
- Easily transmitted mechanically

Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*)
Diseases Caused by Bacteria

Tomato pith necrosis (*Pseudomonas mediterranea* and *P. corrugata*)
Diseases Caused by Viruses

- Insect-transmitted
  - TSWV (thrips)
  - Geminivirus (whitefly)
  - CMV (aphid)

- Mechanically transmitted
  - TMV
Tomato Chlorotic Spot Virus

- Reported on tomato in 2013
Management Strategies

• **Cultural Tactics**
  - Soil quality and soil-borne disease management
  - Mulching
  - Rotation
  - Sanitation
  - Environmental management

• **Resistant Varieties**

• **Fungicides/Bactericides/Biocontrol products**
Soil Quality and Soil-borne Disease Management

• Improving soil quality is critical for optimal soil fertility and crop health. The addition of good quality compost;
  • Increasing soil organic matter
  • Providing nutrients for the crop
  • More extensive and varied microbial community
  • Suppression of soil-borne pathogens
  • Improving plant health

Our previous results showed that high tunnel tomatoes planted in compost-amended soils had significantly less white mold than those in non-amended soils (Baysal-Gurel et al., 2009).
Soil-borne Disease Management

- If a soil-borne pathogen problem develops, soil can be pasteurized or sterilized by a number of methods (Solarization and Steaming).
Solarization

- It is a method of disinfecting by heating moist soil using clear polyethylene (PE) sheet and natural sunlight.
Steaming

Soil steam sterilization is a farming technique that sterilizes soil with steam in open fields, high tunnels or greenhouses.
Mulching

• Plastic (polyethylene) mulch usually used
  – Clear, black or coated
    Black - promotes soil warming
    White - does not promote soil warming
    Red - produces larger plants
    Reflective (aluminum-painted)
  – Reduces transmission of virus diseases - confuses aphid vectors
  – Increases light - improves growth and yield
• Organic growers may use plastic or organic mulches
Rotation

- High tunnels can be built as temporary structures that can be moved from one location to another.

- For immovable structures, crops should be rotated within the high tunnel between plant families.
Sanitation

• Weeds, which may harbor insect pests and some pathogens, and also reduce air movement, should be removed from inside and outside the structure

• Diseased tissue should be removed and disposed
Sanitation

- Clean planting mix
- Clean floors; gravel or plastic/cloth floor coverings on dirt floors
- Disinfest surfaces -
  - Greenshield, Physan 20, dilute bleach
- New or thoroughly cleaned flats
  - Greenshield, Physan 20 or bleach (10%) soaked for 10 min
- Worker cleanliness
- Scout; discard diseased seedlings
Common disinfectants

• Alcohols
• Halogens
• Peroxides
• Quaternary ammonium
• Sodium hypochlorite and
• Botanicals
Requirements for Sanitizers

- Very short contact time (seconds)
- Broadly effective against viruses, viroids, bacteria and fungi
- Not harmful to workers
- Not corrosive to infrastructure or phytotoxic to plants
- Economical
## Testing Sanitizers

### Target pathogens
- *Cmm*
- *Botrytis cinerea*
- *PepMV*
- *ToMV*
- *TMV*
- *Potato spindle tuber viroid (PSTVd)*

<table>
<thead>
<tr>
<th>Product</th>
<th>Active Ingredient</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clorox</td>
<td>5.25% Sodium hypochlorite</td>
<td>10%</td>
</tr>
<tr>
<td>KleenGrow</td>
<td>Didecyl dimethyl ammonium chloride 7.5%</td>
<td>4 ml/L</td>
</tr>
<tr>
<td>Virkon S</td>
<td>20.4% potassium peroxymonosulfate and 1.5% sodium chloride</td>
<td>0.5, 1.0, 2.0%</td>
</tr>
<tr>
<td>Greenhouse Guardian</td>
<td>Trichloromelamine</td>
<td>8 oz/55 gal</td>
</tr>
<tr>
<td>Green-Shield</td>
<td>10% n-Alkyldimethyl benzyl ammonium chloride and 10% n-Alkyl dimethyl ethylbenzyl ammonium chloride</td>
<td>1 tsp/qt</td>
</tr>
<tr>
<td>Non-fat Dry Milk</td>
<td></td>
<td>20% wt:vol</td>
</tr>
<tr>
<td>Vortexx</td>
<td>Hydrogen peroxide 6.9%; Peroxyacetic acid 0.94%; Octanoic Acid 3.3%</td>
<td>1 oz/4 gal</td>
</tr>
<tr>
<td>Octave</td>
<td>Hydrogen peroxide 7.52%; Peroxyoctanoic acid .94%; Octanoic acid 2.72%</td>
<td>1-2 oz/2 gal</td>
</tr>
<tr>
<td>BioSide</td>
<td>Peroxyacetic acid 15%; hydrogen peroxide 22%</td>
<td>1 oz/10 gal</td>
</tr>
<tr>
<td>SaniDate</td>
<td>Hydrogen peroxide 23%; peroxyacetic acid 5.3%</td>
<td>0.5 oz/gal</td>
</tr>
<tr>
<td>StorOx</td>
<td>27% hydrogen dioxide</td>
<td>1.25 oz/gal</td>
</tr>
<tr>
<td>LYSOL</td>
<td>.1% alkyl dimethyl ammonium saccharinate</td>
<td>undiluted</td>
</tr>
<tr>
<td>DES-O-Germ</td>
<td>Poly hexamethylenebuguanideand benzalkonium chloride</td>
<td>100-200ml/100 L</td>
</tr>
<tr>
<td>Menno Florades</td>
<td>9% benzoic acid</td>
<td>3%</td>
</tr>
<tr>
<td>Menno Ter-forte</td>
<td>Didecyl dimethyl ammonium chloride</td>
<td>1%</td>
</tr>
</tbody>
</table>

## Test results

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Cmm</th>
<th>Botrytis</th>
<th>PepMV</th>
<th>ToMV</th>
<th>TMV</th>
<th>PSTVd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 sec</td>
<td>1 min</td>
<td>1 sec</td>
<td>1 min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KleenGrow</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virkon S (0.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virkon S (1%)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>(✔)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virkon S (2%)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Greenhouse Guardian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green-Shield</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vortexx</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BioSide</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SaniDate</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>StorOx</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DES-O-GERM 100</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DES-O-GERM 200</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menno Florades</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Menno- Ter forte</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Clorox</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>(✔)</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Non-fat dry milk</td>
<td>(✔)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>(✔)</td>
</tr>
<tr>
<td>Lysol</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>(✔)</td>
<td>✔</td>
<td>(✔)</td>
</tr>
</tbody>
</table>
Automated Delivery of Disinfectants

Menno Knife
Royal Brinkman, The Netherlands
royal@brinkman.com

Metallo-GermoKnife
http://www.metallotools.nl/

Felco19 Shears with spray device
FelcoSA Switzerland
http://www.felcostore.com/pruners
Sanitation

Seed Treatment

• Important to eradicate or reduce bacterial pathogens on and/or in seed
  • Hot water
  • Chlorox
  • Acid
Environment Management

• Avoid over-watering- Water as early as possible in the day and allow plants to dry before nightfall
• Use well-draining planting mixes
• Moderate temperatures
• Sufficient ventilation
  • Wider plant spacing
  • Pruning
  • Staking/Trellising
  • For high tunnels, the sides and ends should remain open as much as possible to promote air movement
Resistant Varieties

• There are no commercially available sources of resistance to some of the most important diseases, such as bacterial canker and white mold.

• Check with the seed supplier to determine if varieties with resistance to a problematic disease are available.
Resistant Varieties

• Nearly all of the tomatoes used in conventional greenhouse tomato production are grafted and it is an option for high tunnel production.

• Preferred varieties are grafted onto disease-resistant rootstocks.
  • While the cost of grafted transplants is higher than that of non-grafted ones, where soilborne diseases are a problem, this option may be more cost-effective than soil pasteurization or sterilization.
Fungicides/Bactericides/Biocontrol products

• According to the Ohio Department of Agriculture, for purposes of pesticide application, high tunnels are considered to be the same as greenhouses.

• Pesticides that are not restricted use and are labeled for vegetables but without specific greenhouse use directions may be used in high tunnels (and greenhouses) **unless** greenhouse use is expressly prohibited on the label. Thus, a specific label for greenhouse use is not required; but the label must be carefully read to be certain the greenhouse use is not restricted.
Fungicides/Bactericides/Biocontrol products

- Fungicide seed treatment - most seeds are treated with fungicide
  - Organic - synthetic fungicides not used
- Bactericide treatments to manage bacterial Diseases
  - Copper fungicides
- Fungicides to manage occasional fungal diseases - some fungicides are not permitted in greenhouse and hightunnel
Resources

- Midwest Vegetable Production Guide
- VegNet Newsletter (vegnet.osu.edu)
- Twitter @OhioVeggieDoc
- u.osu.edu posts
- Website (www.oardc.osu.edu/sallymiller)