

# Disease Control in High Tunnels

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# 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*



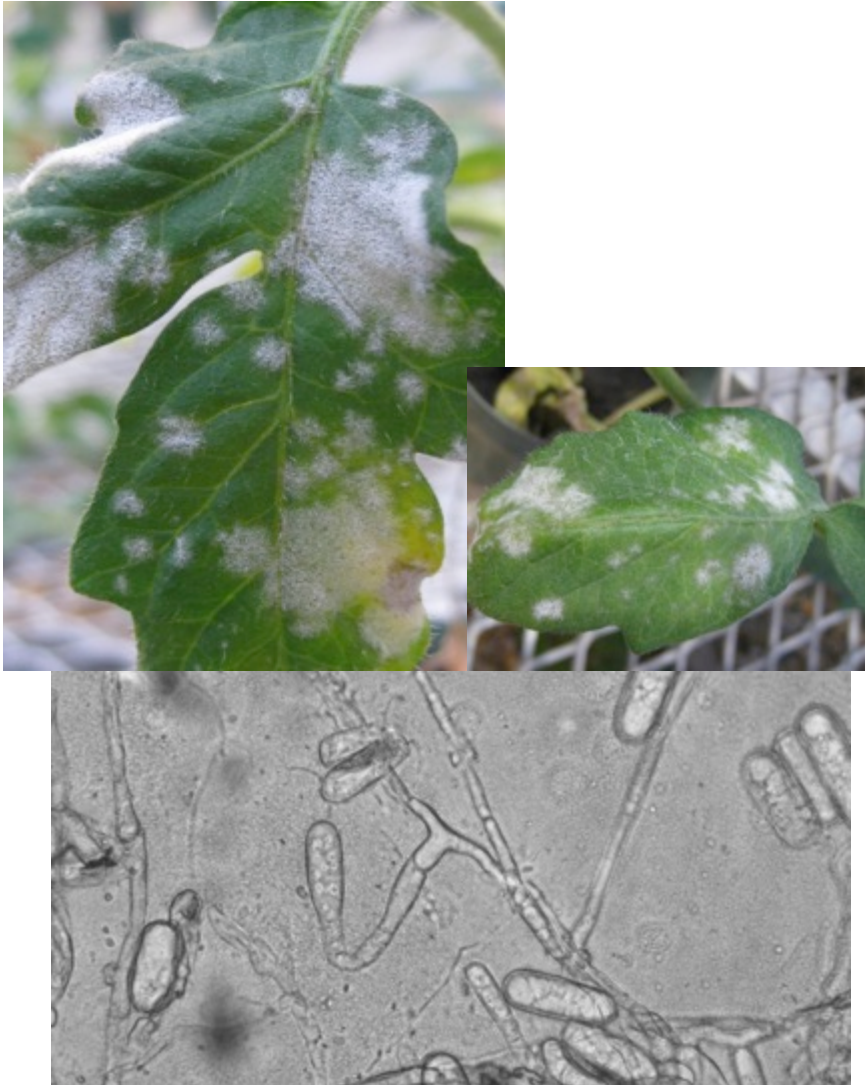
## **Drop**

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*



Botrytis gray mold on tomato stem



Botrytis gray mold on tomato flower



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

# Leaf Mold



*Passalora fulva*



Black Leaf Mold of Tomato  
Caused by *Pseudocercospora fuligena*



# 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



Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*)

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



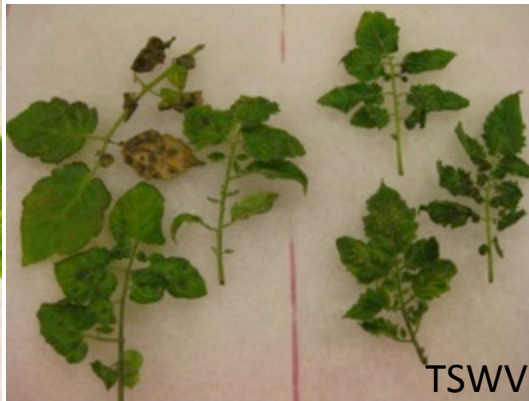
# Diseases Caused by Bacteria



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.

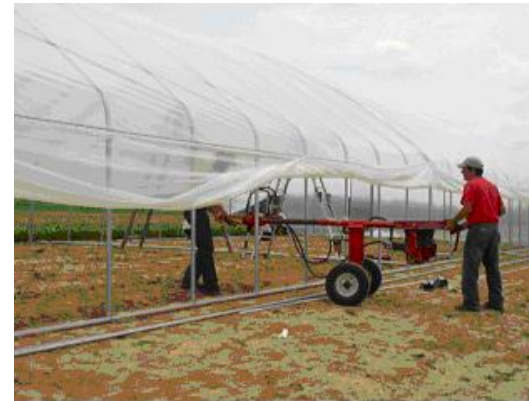


# Mulching

- 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, Phosan 20, dilute bleach
- New or thoroughly cleaned flats
  - Greenshield, Phosan 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)*

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

Baysal-Gurel, F., Li, R., Ling, K., Kurowski, C., Miller, S.A., 2013. Acta Hort.  
 Li, R., Baysal-Gurel, F., Abdo, Z., Miller, S.A., Ling, K., 2015. Virology Journal.

# Test results

Disinfectant	Cmm		Botrytis		PepMV	ToMV	TMV	PSTVd
	1 sec	1 min	1 sec	1 min				
KleenGrow	✓	✓	✓	✓				
Virkon S (0.5%)								
Virkon S (1%)	✓	✓			✓	(✓)		
Virkon S (2%)	✓	✓	✓	✓	✓	✓	✓	✓
Greenhouse Guardian		✓						
Green-Shield	✓	✓	✓	✓				
Vortexx	✓	✓		✓				
Octave		✓		✓				
BioSide	✓	✓	✓	✓				
SaniDate		✓						
StorOx		✓		✓				
DES-O-GERM 100	✓	✓	✓	✓				
DES-O-GERM 200	✓	✓	✓	✓				
Menno Florades	✓	✓	✓	✓		✓	✓	
Menno- Ter forte	✓	✓	✓	✓	✓	✓	✓	
Clorox	✓	✓	✓	✓	(✓)	✓	✓	✓
Non-fat dry milk					(✓)	✓	✓	(✓)
Lysol	✓	✓		✓	(✓)	✓	✓	(✓)

# Automated Delivery of Disinfectants



Menno Knife  
Royal Brinkman, The Netherlands  
[royal@brinkman.com](mailto: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](http://vegnet.osu.edu))
- Twitter @OhioVeggieDoc
- [u.osu.edu](http://u.osu.edu) posts
- Website ([www.oardc.osu.edu/sallymiller](http://www.oardc.osu.edu/sallymiller))

