Managing Tomato Diseases in High Tunnels and the Open-Field



Research and Extension

Disease Management Practices



High Tunnels

- Reduced foliar disease
 - Leaf wetness
- Foliar diseases in tunnels
 - Powdery mildews
 - Botrytis
 - Viruses
- Reduced crop rotation
 - Soilborne pathogens

Photo courtesy: S. O'Connell (NCSU)

Integrated Pest Management

Fung. & Pesticides Biological control Sanitation Cultural control Environmental control Genetic resistance Crop Selection Growing system Site Selection Knowledge/Experience

Outline



- Plant Pathology 101
 Pathogen Biology
- Foliar Diseases
- Soilborne Diseases
- Management Practices

 Cultural practices
 Chemical controls (?)
 Host Resistance (Grafting)

Plant Pathology 101



Life as Plant Pathogen

- On or in soil (soilborne)
 - Soil transients
 - Soil inhabitants
- On or in seed
- Insect vectors
- Perennial plants
- Alternative hosts
 - Weeds
 - Native plants
 - Other crops



FIGURE 1-2 Schematic diagram of the shapes and sizes of certain plant pathogens in relation to a plant cell. Bacteria, mollicutes, and protozoa are not found in nucleated living plant cells.

Pathogen Inoculum



Plant Pathology 101

Signs

- Mushrooms
- Slime mold
- Conk
- Rust
- Cysts
- Ooze
- Mildew
- Sclerotia

Symptoms

- Chlorosis/necrosis
- Malformations
- Mosaic
- Dieback
- Wilt
- Cankers
- Galls

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FIGURE 1-1 Schematic representation of the basic functions in a plant (left) and of the kinds of interference with these functions (right) caused by some common types of plant diseases.

Signature - the specific temporal and spatial expression of signs and symptoms (FJL)

> From: G.N. Agrios. 2005. Plant Pathology. 5th edition. Elsevier AP.

Encountering Problems



- Spatial distribution How is it distributed?
 - Plant
 - families, species, cultivars
 - Host tissue
 - Field topography
 - Low spots, high spots, field edges
 - Region
 - Climate, soil, management systems
- Temporal distribution When did it occur?
 - Event vs Continuous
 - Crop cycle
 - Season
 - Year-to-year

Diagnosis



Encountering Problems

Temporal Distribution

- It happened overnight!!
 - Chronic vs acute
- What areas were affected first?
 - Plant
 - Field
- What has been going on?
 - Weather / Climate
 - Planting, transplanting, harvesting
 - Cultural practices
 - Pesticide applications





Nematode - Coffee

Nutrient stress - Cauliflower

Disease vs Disorder vs Injury



Disease vs Disorder vs Injury



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Foliar Diseases

- Stemphylium spp.
 - Foliar leaf spot
 - Warm wet conditions
 - Wind / rain dispersal
 - Severe defoliation





Gray Leaf Spot



Foliar Diseases

- Powdery Mildews
 - Biotrophic fungi
 - "Dry weather pathogens"
 - Tomatoes, cucurbits





Powdery Mildews

- Management
 - Avoid "green bridges"
 - Environmental control
 - High RH = Spore production
 - Low RH = Spore germination
 - Some resistant varieties
 - Fungicides
 - Biological control



Foliar Diseases



- Botrytis cinerea
 - Necrotrophic fungi
 - Cool, wet weather
 - Very wide host range
 - Ubiquitous pathogen



Botrytis



- Management
 - Environment
 - Needs 3-5 hours moisture
 - Little host resistance
 - Cultural management
 - Fungicides
 - Sanitation

Foliar Diseases

• TSWV

- Bunyaviridae: *Tospovirus*
- Vectored by Thrips
- Overwinters in weeds
- Wide host range





Tomato Spotted Wilt Virus

TSWV Management

- Vector management
 - Scouting
 - Screens
 - Insecticides
- Resistant varieties
- Rogueing
- Manage the weeds ??



Tomato Spotted Wilt Virus



Disease Management Practices

Reflective Mulches

- Mulching is a valuable practice that is often overlooked.
 - Conserve soil moisture
 - Control weeds
 - Increase / reduce soil temperature
 - Disease management
- Organic Mulches
 - Leaves, straw, compost, wood chips, pine straw
- Plastic Mulches
 - Colored mulches
 - Reflective mulches



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Integrated Pest Management

Challenges of managing soilborne diseases

- Microscopic: difficult to sample and monitor
- Patchy distribution
- Persistent and "responsive" inoculum (thresholds)
- Difficult pesticide application
- Pathogen complexes
- Prophylactic control not reactive



Sampling for RKN

Plant Disease Symptoms







- Soilborne pathogens live in or on soil.
- Soilborne diseases occur when pathogens invade the plant root or stem tissue directly from soil.
 - Not all SB pathogens cause SB diseases

Soilborne diseases

- Vascular Wilts
- "Root Rotters"
- Stem Cankers/Galls
- Nematode diseases
- "Damping-off"

Soil Microbial Ecology

The Soil Community is DIVERSE



Soil Microbial Ecology

The Soil Community is DIVERSE



Soilborne Disease Management

Integrated Pest Management

An integrative management system for pests and pathogens focused on increased KNOWLEDGE of production systems.

- Crop rotation
- Sanitation
- Raised beds
- Compost
- Soil solarization
- Biofumigation
- Chemical control
- Biological controls









Crop Rotation at Peregrine Farm (Graham, NC)

Mobile High Tunnels

Cover Crops

Cover Crop Interactions with Soilborne Diseases



Southern Blight (Sclerotium rolfsii)



Crimson Clover is an alternative host for RKN

Sanitation

Sanitation is important for reducing inoculum

- Burial of crop residue (immediately after harvest)
 - Sclerotium rolfsii, Sclerotinia minor
- Rouging of dead and dying plant material
- Clean stakes before re-use
- Removal of volunteer host plants and alternate hosts
- Cleaning equipment between fields/farms
- Essential during transplant production

Raised Beds

Raised Beds

- Making raised beds helps warms the soil and adds to overall crop health.
- Important for "root rotters" and "damping off" diseases
- Soil drainage, aeration





"Root Rotters"



Healthy WHITE roots



Black Root Rot Complex (Strawberries)

Irrigation Management

Managing water is very important

- Water source
 - Standing/running
 - Treatment
- Standing water is BAD
- Soil type and drainage patterns
- At planting
 - Soil moisture and temperature



Mobile Phytophthora zoospores swim to crop roots and infect during periods of standing water.

Phytophthora Crown Rot and Blight - Pepper

Compost-based Systems

Compost can provide disease suppression



Recipe: 30 % Dairy manure 30% Waste Hay 30% Waste Silage 5% Finished compost 5% Clay soil



Compost-based Systems



Soil Solarization

Cook the pathogens out of the soil

- Thermal inactivation
 - Soilborne plant pathogens
 - Insects
 - Weeds
- Efficacy
 - Temperature
 - Exposure time
 - Soil Depth



Soil Solarization in a High Tunnel

2007 Solarization: Maximum Temperatures



Biofumigation





Plastic cover (or rolled seal or water seal)

Water to activate

Plant back



Courtesy: Dr. Carl Sams Professor, Plant Science Dept. University of TN

Biological Controls

Use of Beneficial Microbes as Controls



- BioControl Products
 - Competitive Microbes (*Bacillus* spp.)
 - Parasitic Microbes (T. Harzanium)
 - Induced Resistance
- LOTS of Snake Oils
- Conservationist approach
 - Compost
 - Cover Crops
 - Soil Inoculation

Can we bias the soil community to favor T382 populations?



(Louws et al., NCSU)

Chemical Controls

Chemical controls for soilborne diseases





- Soil Fumigants
 - MeBr (not so much)
 - Telone (nematicide)
 - Chloropicrin (fungicide)
- Chemigation
 - Applied through drip
 - Metam Sodium
 - Traditional fungicides
 - New products
- Always apply according to label



Plant Host Resistance

Understanding Plant Crops as Pathogen Hosts

- Non-host Resistance
- Plant Resistance
 - Multi-genic (Quantitative)
 - Single gene resistance (Qualitative)
- Plant Tolerance





Vegetable Grafting



Tomato Grafting

- Soilborne (Root) diseases
 - Inter-specific rootstocks
- Tomato, Eggplant, Pepper, melons, cucumber





Tomato Grafting for Disease Resistance and Increased Productivity

Cary L. Riverd, Ph.D. Kansas State University Horticulture Research and Extension Center Rank 1 Louws, Ph.D. National Science Foundation Center for Integrated Pest Management



Grafting provides different advantages in various geographic climates across the United States. Grafting can be especially advantageous for growers using high turnels or other season extension techniques, no matter the climate.

Researchers around the world have demonstrated that resistant rootstock—can protect plants against a variety of soil-borne fungal, bacterial, viral and nematode diseases in various climates and conditions. Graffing has been successfully implemented in Apan, Korea, Greece, Morocco, New Zealand, Brunei and elsewhere to battle Verticilium and Fusarium wilt (FW), corky root rot, root-knot nematodes, bacterial wilt, southern blight and other disease.

Photo courtery C. Rivand

(Rivard and Louws, 2011)

Soilborne/Root Diseases

- Fusarium wilt is caused by *Fusarium oxysporum*.
 - Unilateral wilting
 - Yellowing of leaves
 - Browning of xylem







Fusarium Wilt



(Rivard and Louws, 2008)

Root-knot Nematodes

- Root-knot Nematodes
 - Meloidogyne spp.
 - Root galls
 - Stunting and poor vigor
 - Prefer light soil





Verticillium Wilt

- Verticillium dahliae
 - Loss of vigor
 - Wilting and leaf necrosis
 - Favored by cool wet weather
 - Race 2 prevalent in WNC
 (Bender & Shoemaker, 1984)
 - Reliance on fumigation







Tomato Grafting - Verticillium



LSD *P* = 0.05

Economic Returns

Net returns of grafting (\$/acre) : 2008

	Non-grafted*	Maxifort*	(Max-Std)
18" Spacing	\$44,525	\$47,366	\$2,841
24" Spacing		\$47,827	\$3,302
36" Spacing		\$45,533	\$1008

Net returns of grafting (\$/acre) : 2009

	Non-grafted*	Maxifort*	(Max-Std)
umigated	\$47,739	\$60,699	\$12,960
Ion-fumigated		\$57,677	\$9,938

* Values = Gross revenue – harvest costs – transplant costs

Selling price = \$0.66 per lbs

Summary

Integrated Management of Soilborne Diseases

- Rotate crops (3-7 years)
- Create a "healthy" soil
 High microbial activity
 Promotes plant health
- Utilize resistant varieties
- Manage water
 - Source
 - Drainage / saturation
- Utilize therapeutics
 - Solarization, biofumigation, biocontrols



Summary

Integrated Management of Foliar Diseases

- Manage environment
- Don't work plants when they are wet
- Sanitize tools
 - Pruning
- Scout for insects/viruses
 Rogue plants



Systems Approach

- Disease suppression
- Plant growth promotion
- Good yields
- Weed suppression
- Nutrient cycling/CEC

• Biologicals

Knowledge of pathogens

function

Ogical

- Soil community
- •Crop diversity

Farming system Biodiversity

Multiple crops over time and space to foster high biodiversity, multi-pest suppression, and vigorous plant health

QUESTIONS??

Por la sanidad de las fincas aledañas: Lavarse bien las BOTAS en la ZONA DE DESINFECCIÓN