Cultural Practices for Plant Disease Control

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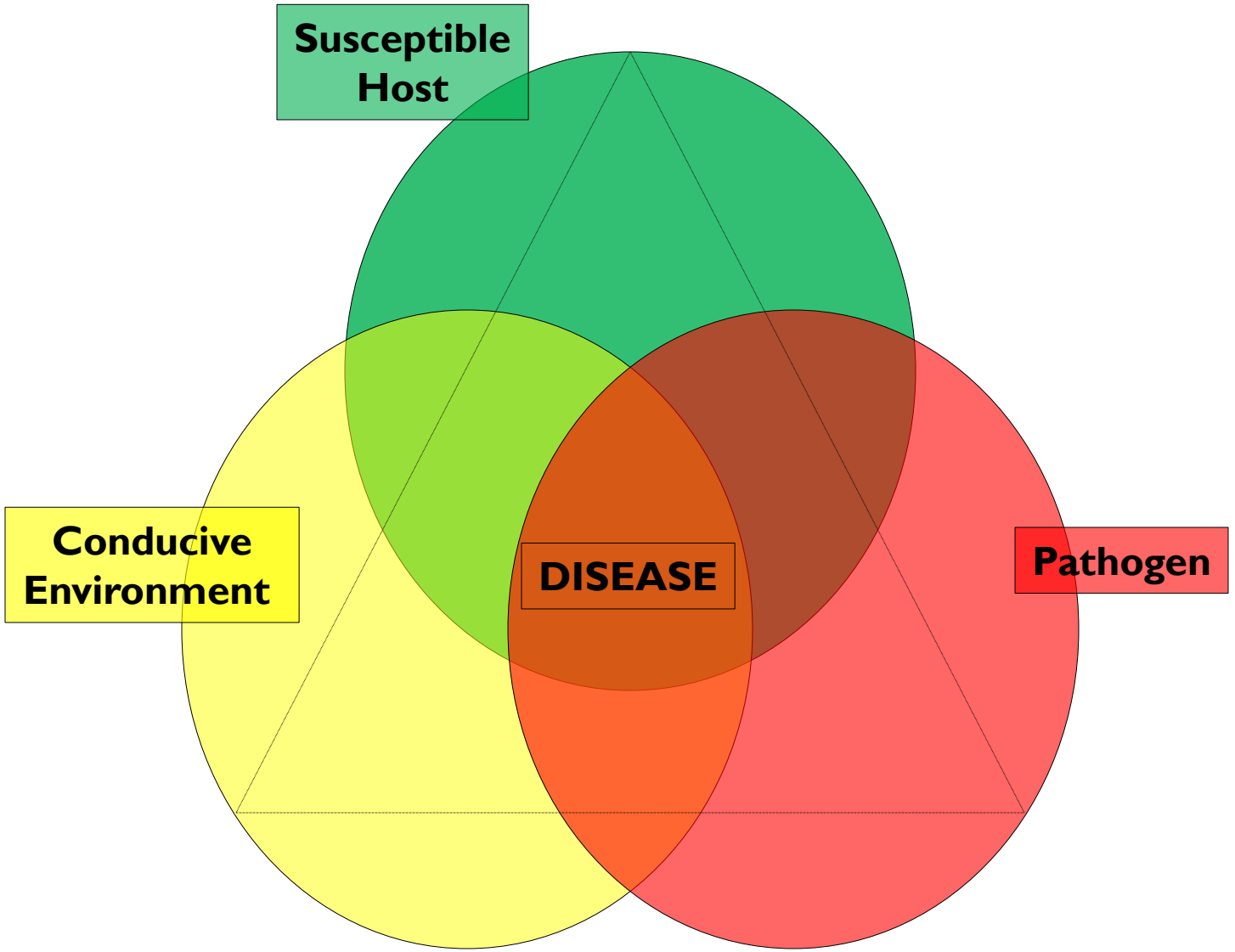
Holistic Approach to Plant Health

- Consider the environment
- Integrate disease management strategies
- Crop diversity
- Knowledge of previous diseases at field sites
- Cropping history

Plant Disease Triangle

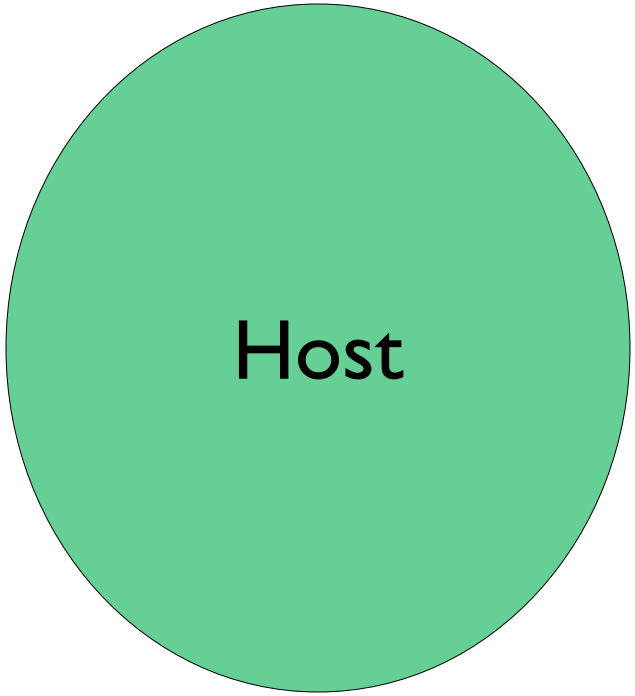


Things to consider…

- A single plant pathogen can attack different parts of a plant
- Symptoms can vary with plant part and age of the plant
- More than one pathogen or disease can occur on a plant at one time
- Symptoms may appear identical for two different diseases

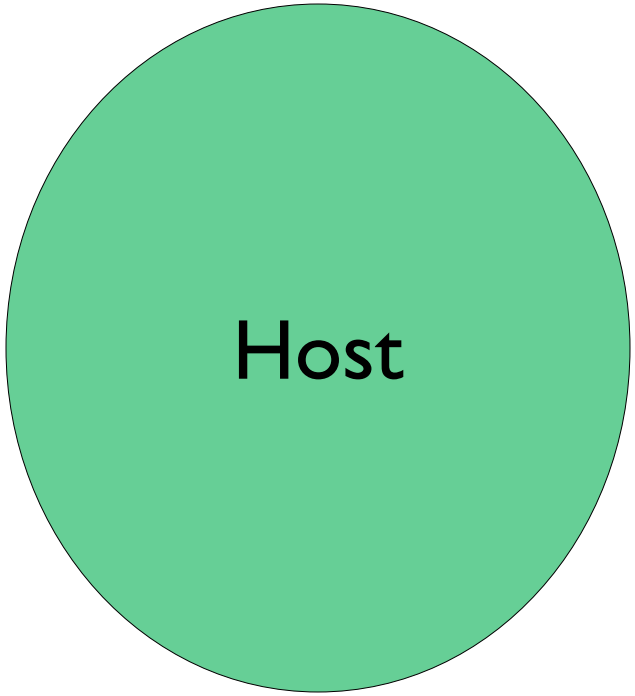
Focus on the host plant

- Genetic resistance to disease in the host plant
- May involve a single gene or many genes
- Practical
- Affordable
- ***First*** line of defense
- Preventative measure



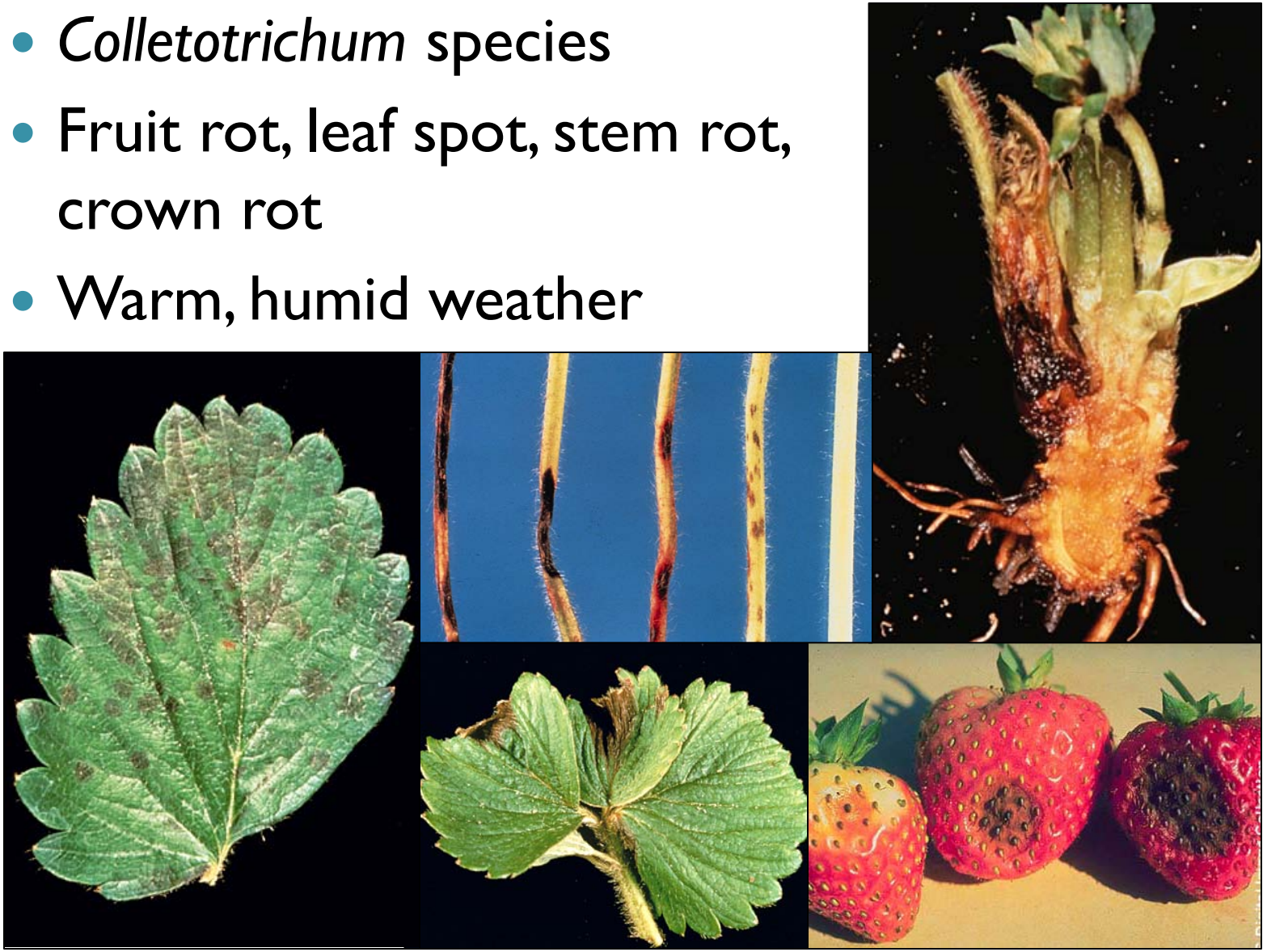
Focus on the host plant

- Drawbacks…
  - Genetic resistance not always available
  - Desirable traits may be found in susceptible varieties
  - Resistance may be overcome by pathogen



Disease Problem – Strawberry Anthracnose

- *Colletotrichum* species
- Fruit rot, leaf spot, stem rot, crown rot
- Warm, humid weather



Photos courtesy APS Press

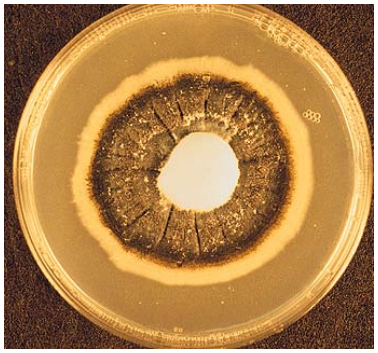
Resistant Varieties

Strawberry anthracnose,
Colletotrichum acutatum

Photo courtesy S. Bost

Disease Problem – Verticillium wilt in tomato

Verticillium wilt, caused by *V. dahliae*



Photos courtesy APS Press

- Soilborne pathogen
- Large host range
- Causes stunting, wilting, slow decline
- Genetic resistance available for many vegetable crops
- Primary control

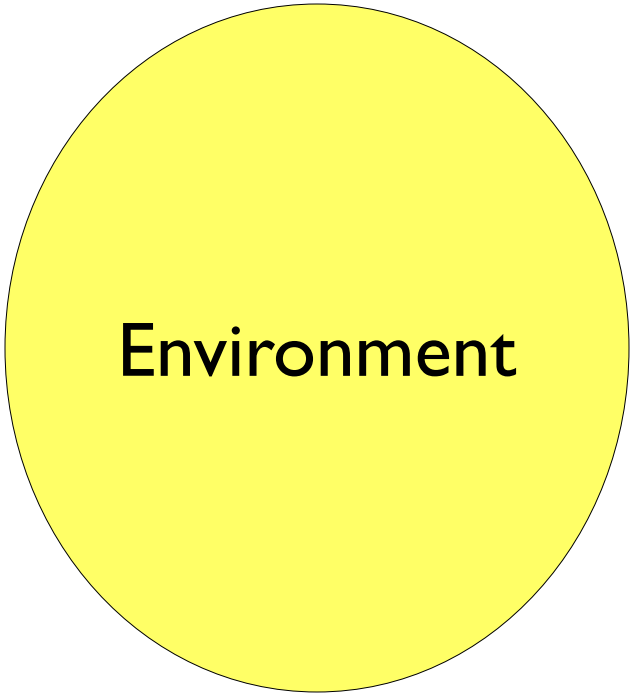
Grafting tomato onto root stock resistant to bacterial wilt

- Grafted 'Celebrity' onto resistant root stocks
- Extra cost of grafting = $2,275/A
- Net return:
  - Non-grafted Celebrity: Yield = 5.4 T/A, $8,780/A
  - Celebrity-RST-04-104T: Yield = 19.5 T/A, $59,635/A

Non-grafted controls in forefront.
Photo courtesy S. O'Connell

- Project by NC State Univ. (Suzanne O'Connell et al.) & Black River Organic Farm;unded by Organic Farming Research Foundation

Consider the Environment



- Disease escape tactics
- Irrigation practices
- Plant density
- Raised beds
- Site selection
- Soil pH
- Soil fertility
- Soil organic matter
- Preventative practices

Disease escape tactics

- Alter planting date so that seedlings emerge from soil faster, or the crop matures earlier than the time period when disease pressure is greatest due to environment
- Plant early maturing varieties to avoid time when environment favors disease

Water/Irrigation

- Stress, caused by drought and excess water, makes plants more susceptible to disease
- Avoid overhead irrigation
  - Periods of prolonged leaf wetness trigger growth and infection by most plant pathogens
- Consider your source of water – Is it a reservoir for pathogens?

Humidity

- Ventilate greenhouses and high tunnels to release warm, moist air
  - High humidity promotes plant disease
  - Diseases that are a problem in the greenhouse environment, are likely to be problems in high tunnels, such as
    - Botrytis gray mold
    - Phytophthora late blight
    - Sclerotinia white mold

Early blight – *Alternaria* spp. on tomato

Photo courtesy APS Press

- Drought makes plants more susceptible
- Overhead irrigation spreads fungal spores and causes leaf wetness, which increases infection

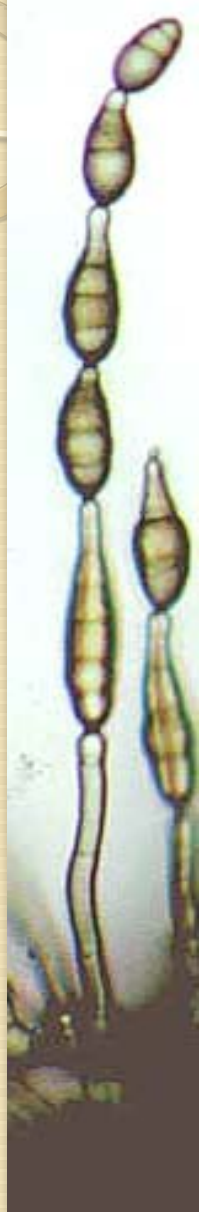


Photo courtesy G. Barron

Late blight – *Phytophthora infestans* on tomato

Photos courtesy APS Press

- Disease favored by leaf wetness
- Severe disease causes defoliation and fruit rot
- Probably brought in each year on diseased transplants
- Can overwinter in greenhouses

Plant density – Adequate spacing

Photo courtesy S. Bost

- Dense plantings reduce air movement and light
- Slow drying of leaf and stem surfaces encourages infection by pathogens

Site selection - Improve drainage

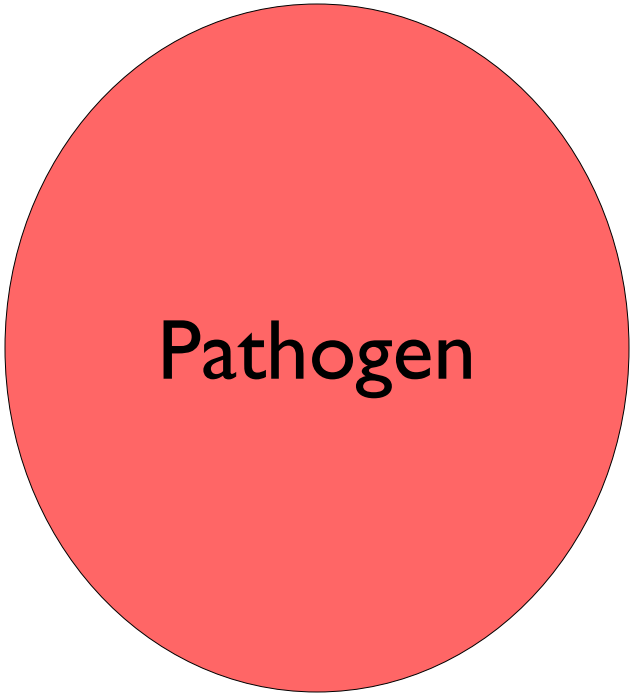
- Incorporation of organic matter (cover crop, compost, etc.) into soil and
- Use of raised beds promote good drainage

Photos courtesy S. Bost

Proper plant nutrition and soil pH

- Management of plant nutrition to reduce disease depends on the combination of pathogen and plant
- High levels of nitrogen can produce lush, succulent plants that are more susceptible to disease
- Any deficiency or excess of any nutritional element can cause physiological disorder and reduce resistance of plants to disease

Focus on the pathogen



- Crop rotation
- Clean planting materials
- Sanitation
- Eliminate insect vectors
- Eliminate weedy hosts
- Eradicate the pathogen
  - Biofumigation
  - Soil solarization

Crop rotation benefits

- Improves soil quality
  - Green manures and cover crops increase soil organic matter
  - Crops with different rooting depths loosen compacted soils and optimize use of water and nutrient resources
- Increases soil fertility
  - Leguminous crops
- Manage plant diseases
  - Reduce inoculum of plant pathogens
- See UT Extension publication W235-E (Wszelaki and Broughton)

Crop rotation considerations

- Does the pathogen have a large host range?
- Is the pathogen soilborne? Or foliar?
- Can it survive for a long time in soil without a host?
- Am I using clean planting materials (seed, transplants, etc.)?

Crop rotation is family rotation

- To rotate, plant crops from a different family in following years

Family*	Example members
Alliaceae	Onion, garlic, shallot, leek
Apiaceae	Carrot, parsley, celery, parsnip
Brassicaceae	Rutabaga, kale, broccoli, Brussels sprouts, cauliflower, radish, cabbage, radish, mustard, turnip
Cucurbitaceae	Cucumber, cantaloupe, watermelon, pumpkin, squash, gourd
Fabaceae	Bean, pea
Solanaceae	Potato, tomato, pepper, eggplant

*There are other families represented by 1 or 2 vegetable crops

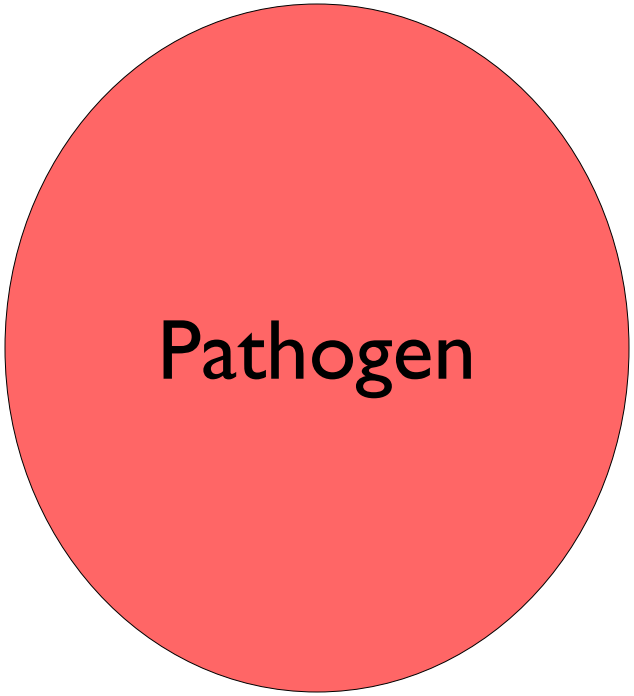
Crop rotation

- Rotations out of the susceptible crop for 2-3 years are adequate to reduce populations of most foliar pathogens
- Rotations of 4 years are good for many soilborne pathogens
- Longer rotations are needed for some soilborne pathogens
  - Fusarium rot of asparagus – 8 years
  - Clubroot of cabbage – 7 years
  - Fusarium wilt of muskmelon – 5 years

Crop rotation

- Consider proximity of fields – the greater the distance of susceptible crops to a field with a disease problem, the better
- Consider compatibility of crops in your rotation – some plants produce chemicals that inhibit growth of other plants (e.g., cabbage, sorghum, etc.)

Focus on the pathogen



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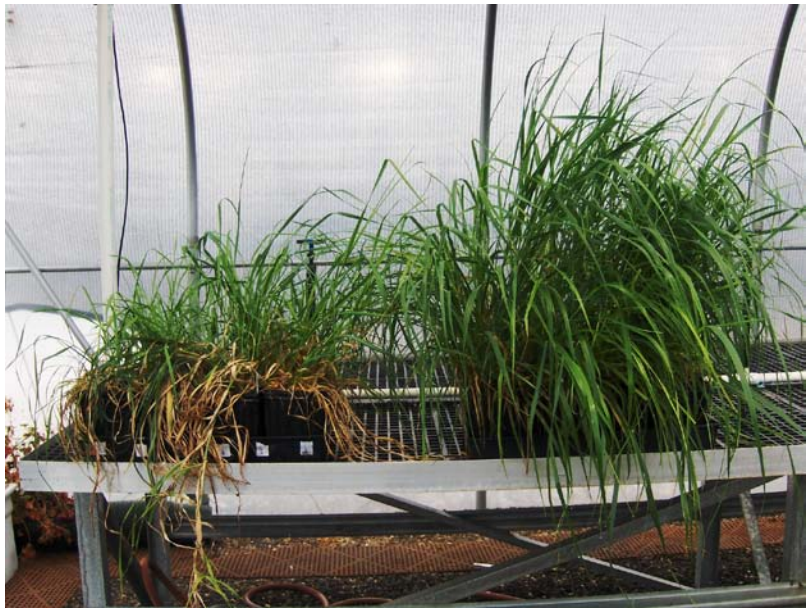
Use clean (pathogen-free) seed

- Many pathogens are seed-borne; found on the exterior or interior of seed
- Use certified seed if possible
- Exterior seed pathogens can be removed with disinfectant (bleach, hydrogen peroxide, ethanol – check for approvals with certifying agency)
  - Treatment time and concentration of disinfectant depends on seed size and seed coat



Switchgrass – (Left) plants grown from seed that was not cleaned; (Right) plants grown from seed disinfected with bleach and ethanol.
Photo by B. Ownley

Bacterial diseases are often seed-borne

- Use clean seed
- Avoid overhead irrigation
- Space plants to allow drying
- Practice sanitation

Bacterial canker

Bacterial speck

Bacterial spot

Photos courtesy APS Press

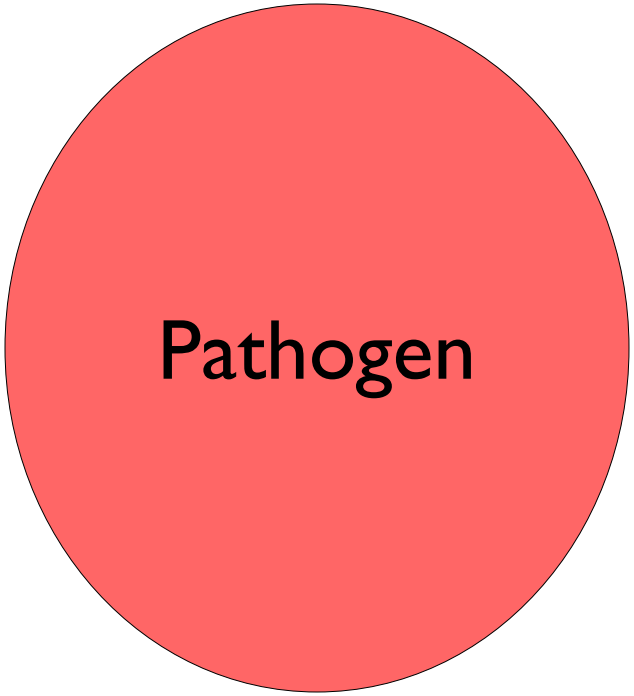
Use clean transplants

- Start with disease-free transplants
- Avoid soil contact with transplants – cover soil or place trays onto benches

Early blight stem lesions

Photos courtesy S. Bost

Focus on the pathogen



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Sanitation

- Destruction or removal of plant pathogens from tools and farm equipment
- Removal and destruction of diseased plants from the field, greenhouse, or high tunnels

Sanitation

- Plow under crop residue after harvest to speed decomposition of debris
- Turning plow best, but can cause erosion problem
- Disk plow is adequate, unless southern blight (*Sclerotium rolfsii*) is a problem

Photos courtesy S. Bost

Clean stakes used for trellising

- Wash soil and debris from stakes
- Disinfect with a 10% bleach solution

Photo courtesy S. Bost

Sanitation

- Remove diseased plant parts where practical (greenhouse, high tunnels, small plots)

Target spot (*Corynespora*) of cucumber.
Too late for removal of infected plant parts.

Photo courtesy S. Bost

Roguing

- Remove diseased plants (and pathogen)
- Avoid scattering the pathogen

Sclerotia and white mycelium

Southern blight, *Sclerotium rolfsii*

Photos courtesy S. Bost

Cull piles in production fields are not a good idea

Photo courtesy S Bost

Remove it and bury it

Control other pests

- Weed control
  - Competition for water and nutrients
  - Harbor pathogens
- Insect control
  - Wound plants
  - Vector pathogens
  - Spread diseases

Photo courtesy R. Bessin

Striped and spotted cucumber beetles spread bacterial wilt

Photo courtesy Manitoba Weekly Vegetable Report

Insect-transmitted diseases and their vectors

Mosaic virus -- aphids

Tomato spotted wilt virus -- thrips

Cucurbit yellow vine disease -- squash bugs

Cucurbit bacterial wilt -- cucumber beetles

Photos courtesy S. Bost

Tomato spotted wilt virus

Most viruses are insect-borne and not controlled by crop rotation

Photos courtesy S. Bost

Biofumigation

- Certain members of the mustard family release chemicals that are toxic to plant pathogens
- Caliente mustard, *Brassica juncea*, is commonly used for this purpose
  - Used as a green manure
  - Mustard seed meal is applied

Photo courtesy S. Bost

Biofumigation with mustard as a green manure

- Cover crop is cut down and quickly plowed under
- Plant material produces a gas in the soil

Photo courtesy S. Bost

Biofumigation with mustard seed meal

- Mustard seed meal may be applied to the row and tilled into soil
- Plastic mulch may be applied to the row to slow escape of the gas

Photos courtesy S. Bost

Other cover crops

- Trap crop – stimulate spore germination
- Release bioactive chemicals (mustards, mints, sorghum, etc.)

Monarda "Marshall's Delight" (mint family)
Photo courtesy VanBloem Gardens

Solarization

Photo courtesy C. Canaday

Solarization

Not solarized

Solarized

Photos courtesy C. Canaday

Photo credits

- Multiple photos - APS Press, Minneapolis, MN
- Multiple photos - Steve Bost, University of Tennessee
- Photo of *Alternaria alternata* - George Barron, University of Guelph, Canada (http://www.uoguelph.ca/~gbarron/MISC2003/nialln2.jpg)
- Grafting tomatoes - Suzanne O'Connell, NC State University, Raleigh (http://ofrf.org/funded/highlights/oconnell_07f30.html)
- Photo of spotted cucumber beetle – Manitoba Weekly Vegetable Report (http://www.gov.mb.ca/agriculture/crops/horticulture/report/07-09-07/07-09-07spottedcukebeetle.jpg)
- Photo of striped cucumber beetle – Ric Bessin, University of Kentucky (http://www.uky.edu/Ag/kpn/stcucbtl.gif)
- Photo of Monarda Marshall's Delight – VanBloem Gardens (http://www.vanbloem.com/_ccLib/image/plants/DETA-1016.jpg)
- Photos of soil solarization - Craig Canaday, University of Tennessee