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

In nature, disease is the exception, not the rule
Plant Disease Triangle

- Susceptible Host
- Conducive Environment
- Pathogen

DISEASE
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

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

Verticillium wilt, caused by *V. dahliae*

Photos courtesy APS Press
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

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

Photo courtesy APS Press

Photo courtesy G. Barron
Late blight – *Phytophthora infestans* on tomato

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

Photos courtesy APS Press
Plant density – Adequate spacing

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

Photo courtesy S. Bost
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

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

*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

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

Photos courtesy APS Press
Use clean transplants

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

Photos courtesy S. Bost
Focus on the pathogen

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

Southern blight, Sclerotium rolfsii

Sclerotia and white mycelium

Photos courtesy S. Bost
Cull piles in production fields are not a good idea

Remove it and bury it

Photo courtesy S Bost
Control other pests

- **Weed control**
  - Competition for water and nutrients
  - Harbor pathogens

- **Insect control**
  - Wound plants
  - Vector pathogens
  - Spread diseases

Striped and spotted cucumber beetles spread bacterial wilt
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
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- 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)
- Photos of soil solarization - Craig Canaday, University of Tennessee