Crop Rotation for Disease Prevention

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Crop Rotation as defined by NOP

The practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that CROPS OF THE SAME SPECIES OR FAMILY ARE NOT GROWN REPEATEDLY without interruption on the same field.
Crop Rotation - Disease Prevention

General Approach:
Grow non-host plants until the pathogen in the soil dies or its population is reduced to a level that will result in negligible crop damage.
Crop Rotation - Disease Prevention

Successful Approach:
Proactive, Preventive
Part of integrated program
Based on understanding pathogen biology
Recognize other reasons to rotate (inc. weeds)
Plant Pathogens in Soil

Soil Inhabitants (saprophytic phase)
- Fungi (e.g. *Pythium*, *Rhizoctonia*, *Fusarium*)
- Bacteria (e.g. *Erwinia*, *Rhizomonas*, *Streptomyces*)

Soil Survivors
- Nematodes (on weed host roots, cysts)
- Fungi (survival structures, e.g. *Sclerotinia*, *Verticillium*, *Rhizoctonia*)
- Fungi (surviving in plant debris, e.g. *Alternaria*, *Septoria*)
- Bacteria (surviving in plant debris, e.g. *Clavibacter*, *Pseudomonas*, *Xanthomonas*)
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Pythium Root Rot - Tomato
Pythium Root Rot - Onion
Aphanomyces Root Rot - Pea

cf. Beth Gugino
Plant Pathogens in Soil

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White Mold Cabbage

sclerotia

Huge host range: > 360

cf. Helene Dillard
Tomato White Mold
apothecia
Eruption of Ascospores
Microsclerotia of *Verticillium* can survive 13 yrs.
Sexual Stage of Cucurbit Powdery Mildew Fungus can Overwinter in Northern US
Cucurbit Powdery Mildew

Long-distance wind-dispersed spores are primary source.
Successful Rotation – Disease MGT

Pathogens in a family are similar but also different!

Example: downy mildew pathogens
Downy Mildew Pathogens
Some survive in soil:
    Sunflower DM.
Most are dispersed by wind very long distances:
    Cucurbit DM + basil DM.
Some can be in seed:
    Basil DM.
Most have narrow host ranges:
    Cucurbit DM + basil DM.
Sunflower Downy Mildew

Affects > 80 species in 35 genera, weeds and horticultural crops.
Downy Mildew Pathogens

Why can some survive in soil?

They produce oospores, thick-walled survival spore type resulting from sexual reproduction.

Most spores are asexual.
IMPORTANT NOTE!!

Other Oomycete pathogens (inc late blight) could produce oospores if both mating types present.

Then rotation WILL be needed!
Successful Rotation – Disease MGT

Based on knowing pathogen.
- How does it survive, how long.
- Other hosts (including weeds).
- Other sources (seed, wind-dispersed spores, insects)
Phytophthora Blight

Pathogen: *Phytophthora capsici*

Hosts: all cucurbits, pepper, eggplant, tomato, NOT potato, beans (snap and lima), weeds (esp. purslane)
Successful Rotation – Disease MGT

Knowledge of pathogen ability to move in air


Short distance. Large spores and those water-splashed.

Alternaria leaf spot, early blight.

Septoria leaf spot, bacteria.
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Successful Rotation – Disease MGT

Pathogen moves in air short distances

Large spores:

  Alternaria leaf spot, early blight.

Water-splash dispersed:

  Septoria leaf spot, bacteria.
Black Rot – Cabbage + Cauliflower
Crucifers – Alternaria Leaf Spot
Bacterial Leaf Spot Pepper
Bacterial Leaf Spot - Pumpkin
Bacterial Leaf Spot
Pumpkin
Plant Pathology Confusion

Same name – Different pathogen

Bacterial leaf spot

Pepper: *Xanthomonas campestris pv. vesicatoria*

Cucurbitis: *Xanthomonas campestris pv. cucurbitae*
Diseases of Tomato caused by pathogens that can survive in soil

- Anthracnose
- Early blight
- Bacterial canker
- Bacterial spot
- Bacterial speck
- Septoria leaf spot
Parsley – Septoria Leaf Spot
Lettuce
Septoria
Leaf Spot
Cucurbits – Plectosporium Blight
Cucurbits – Plectosporium Blight

Pumpkin and summer squashes most susceptible
Successful Rotation – Disease MGT

Hasten decomposition of infested crop debris.
Immediately after harvest:
Remove debris when feasible.
Flail chop thoroughly.
Incorporate into soil.
Promote soil health.
Successful Rotation – Disease MGT

Manage other potential sources of the pathogen. Many surviving in debris can be seed-borne:

- Crucifers: black rot, Alternaria leaf spot.
- Pepper: bacterial leaf spot.
- Tomato: early blight, Septoria leaf spot, bacterial speck, spot + canker.
Hot-Water Seed Treatment

Protocol for Tomato Seed:
Preheat seed for 10 min. at 100°F.

Transfer to 122°F for 25 min.

Cool seed immediately and dry completely prior to sowing or re-packaging.
Black Rot – Ornamental Kale
Black Rot
Ornamental Kale
Black Rot – Ornamental Kale
Successful Rotation – Disease MGT

Avoid moving pathogen into rotated area.

Clean equipment and shoes between field sections.

Control water drainage.
cf. C. L. Mohler
Successful Rotation – Disease MGT

Part of an integrated management program.
Managing Soil-borne Diseases

Know what diseases could occur.
Avoid introducing pathogen to farm.
Avoid moving pathogens between field sections. 
Rotate land based on pathogen hosts.
Control weeds.
Use biofumigants and other cover crops.
Apply compost and other organic amendments.
Apply biopesticides.
Avoid favorable conditions.
Promote good soil health.
Soil solarization.
At first detection, add fungicides to program.
Biofumigant Mustard Cover Crop

Select variety high in glucosinolates. Plant in early spring or fall. 10 lb/A. 50-100 lb/A N. Drill or broadcast. Incorporate after 5-6 weeks flowering:

- Flail chop well early in day when coolest.
- Incorporate asap.
- Seal surface.
- Plant >1 week later.

Lots of bees and beneficials.
Effective for: nematodes, Phytophthora, Pythium, Rhizoctonia, Sclerotinia, Fusarium, and Verticillium

Glucosinolates in Mustard converted to allyl-isothiocyanate (methyl isothiocyanate is in Metam Sodium)

Mustard seed immature:
Phytophthora Blight
Healthy zucchini only after mustard.

8-15-08

Phytophthora blight.
Successful Rotation – Disease MGT

Incorporating lots of biomass (e.g. cover crop) stimulates microbial activity which can include soil inhabitant pathogens (e.g. *Pythium*).
Successful Rotation – Disease MGT

Legumes (e.g. clover, pea, bean, vetch, lupine) stimulate microbial activity.

Compromises: hairy vetch reduced Fusarium wilt but is a good host for root-knot nematodes.
Soil Solarization Suppresses White Mold severe prior
cf. Paul Vincelli
Biopesticides – Soil-borne Pathogens

Regalia. Extract of giant knotweed
Actinovate. *Streptomyces lydicus*
Contans. *Coniothyrium mimitans*
Double Nickel. *Bacillus amyloliquefacinens*
RootShield. *Trichoderma harzianum*
Serenade Soil. *Bacillus subtilis*
SoilGard. *Gliocladium virens*
Bio-Tam (aka Tenet). *Trichoderma asperellum + Trichoderma gamsii*
Biopesticides – Soil-borne Pathogens

Labeled for Use before or at Planting

**Actinovate.** Apply to seed as a spray or dry coating, or to soil as a drench or in-furrow at seeding.

**Bio-Tam (aka Tenet).** Apply to substrate mix or in-furrow.

**Double Nickel.** Apply to transplants before or at transplanting, or to soil broadcast, injected, via drip, or in-furrow.

**RootShield.** Can be applied as a drench to potting soil or field soil, or in furrow or broadcast.

**SerenadeSoil.** Apply as a directed spray in the furrow or as a soil drench.

**Regalia.** Apply as in-furrow spray or plant dip before transplanting. Also can be applied as soil drench.
Crop Rotation on Organic Farms: A Planning Manual

NRAES 177

This book provides an indepth review of crop rotation and its many applications, such as improving soil quality and health, and managing pests, diseases, and weeds. The authors consulted with expert organic farmers to develop crop rotation guidelines and strategies that can be applied under various field conditions and with a wide range of crops. In addition, the book includes instructions for making crop rotation planning maps using Microsoft Excel and discusses intercropping and crop rotation during the transition to organic farming.

The manual will be a valuable resource for farmers, educators, students, and professional advisors interested in the do's, don'ts, how's, and why's of crop rotation. Crop Rotation on Organic Farms will be most applicable for the Northeastern United States and Eastern Canada, but will also be useful in other parts of the U.S., Canada, and even Europe.

Financial support from SARE (Sustainable Agriculture Research & Education) resulted in a 30% reduction in the price of this book.

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- The NEON “Managing a Crop Rotation System” Chart

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Do not wait until you have a problem!
Focus on pathogens that cannot survive well in soil.
Focus on host range of pathogens, not just plant families.
Manage other sources of pathogen.