THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Maximizing seed health in your seed saving practices

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Department of Plant Pathology

What will you learn today?

- How do seedborne diseases spread?: A case study with quinoa
- Plant pathology basics
- Important seedborne diseases of vegetables
- Seed treatments to prevent seedborne disease spread
- Hands-on seed treatment demo

Plant Pathology Forensics: A Quinoa Case Study

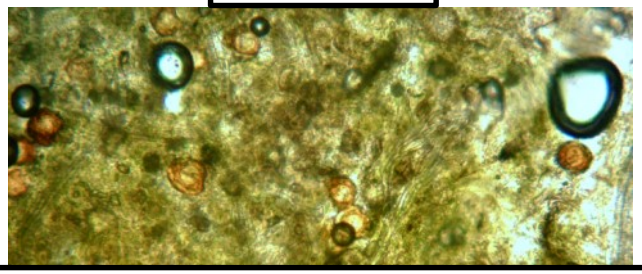
Quinoa Downy Mildew

Quinoa is native to the Andean Region of South America

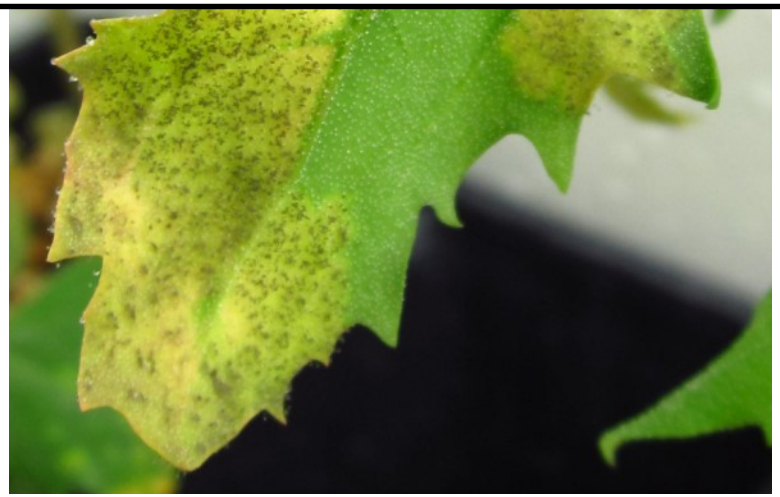
- But quinoa downy mildew has been reported in Canada, Britain, Egypt, Morocco, South Korea, Turkey, Denmark, India, and etc.
- How does this disease spread???

Sporangia

Oospores



How was *P. variabilis* introduced to United States?

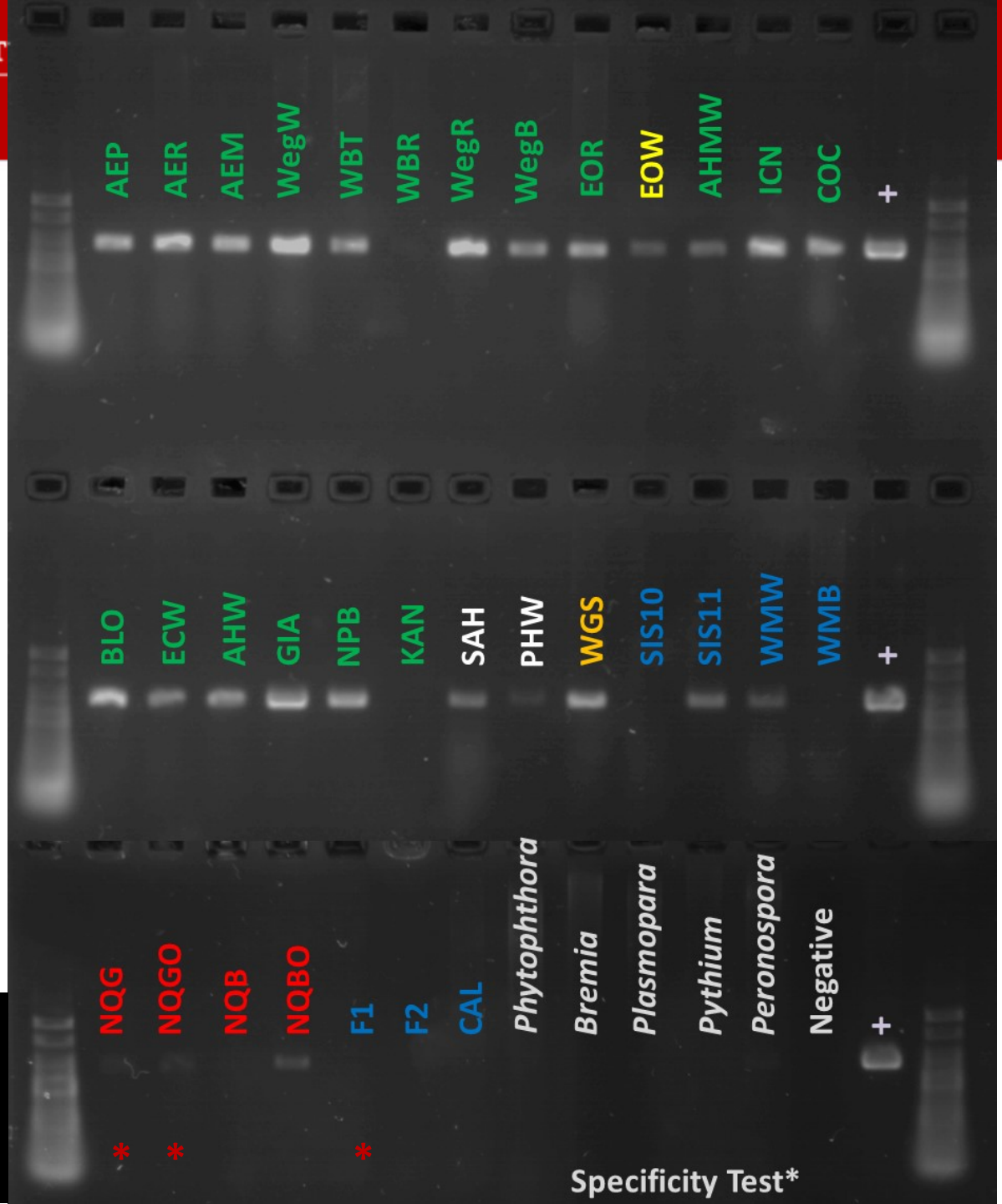


Did seedborne oospores serve as inoculum?

Is *P. variabilis* detectable in quinoa seeds?

- 25 of 32 lots tested positive based on sequence analysis
- 23 of 32 lots tested positive with PCR based detection method
  - 15 of 16 quinoa seed lots purchased in State College, PA tested positive

Bolivia Ecuador
Peru India
USA Canada

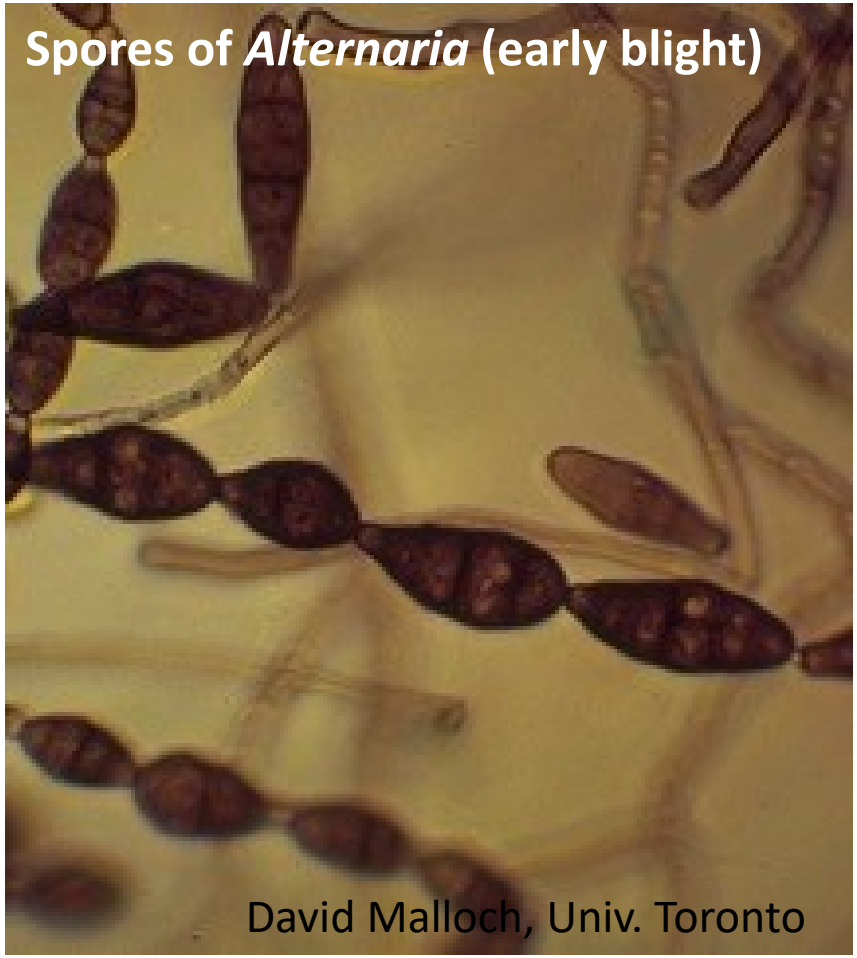


What Causes Disease in Plants?

- Fungi
- Oomycetes
- Bacteria
- Viruses
- Viroids
- Nematodes
- Parasitic Plants

Fungi That Attack Plants

- Fungi (molds) are microscopic plant-like organisms
- Most fungi are NOT plant pathogens
- Grow vegetatively by production of long filaments called *hyphae*
- Most produce spores
- Many also produce specialized structures (pycnidia, ascocarps, sclerotia, etc.) for reproduction and/or survival



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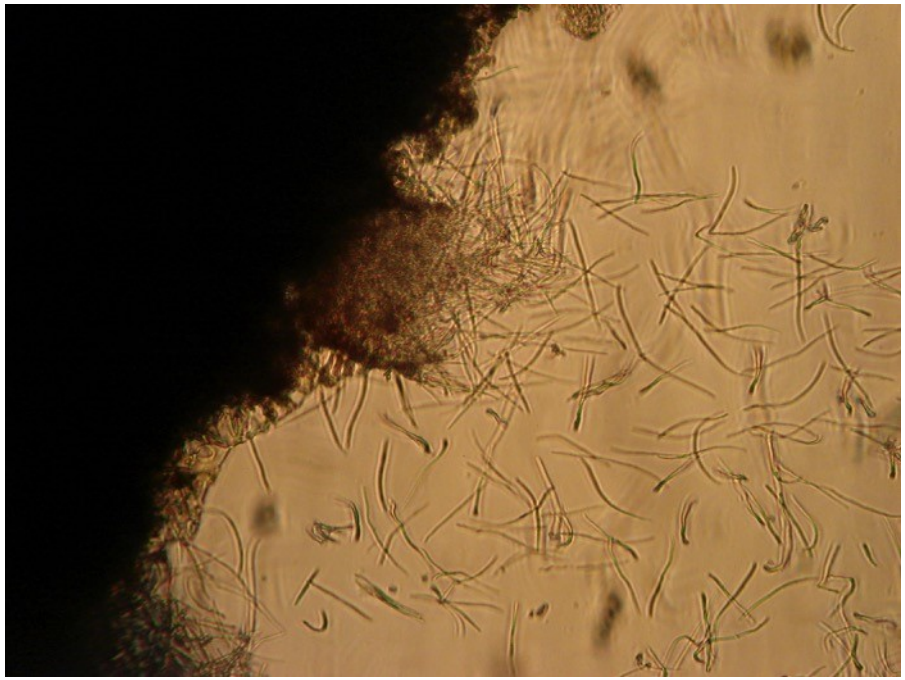
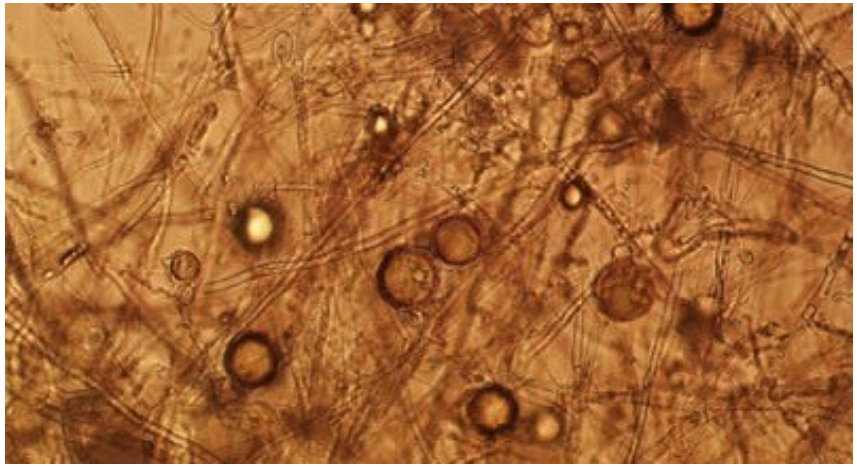


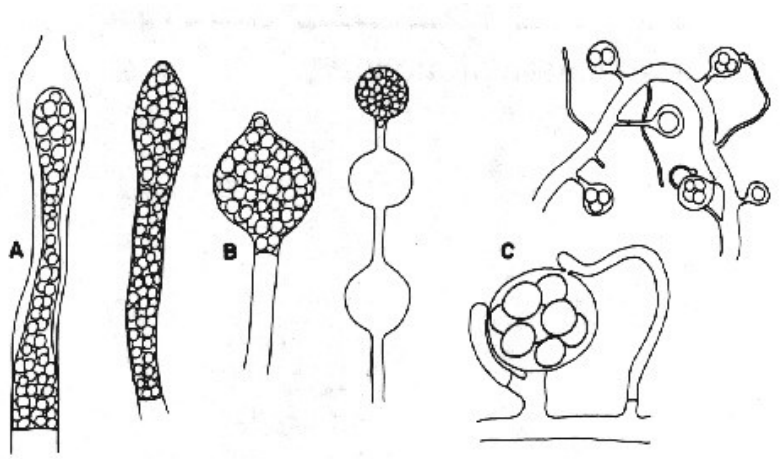
Pycnidium and spores of *Septoria*

Oomycetes That Attack Plants

- "Fungal-like" organisms related to diatoms and brown algae
- Reproduce in water ("water molds")
  - Produce swimming spores ("zoospores")
- Produce specialized structures for long-term survival (oospores)

Phytophthora oospores

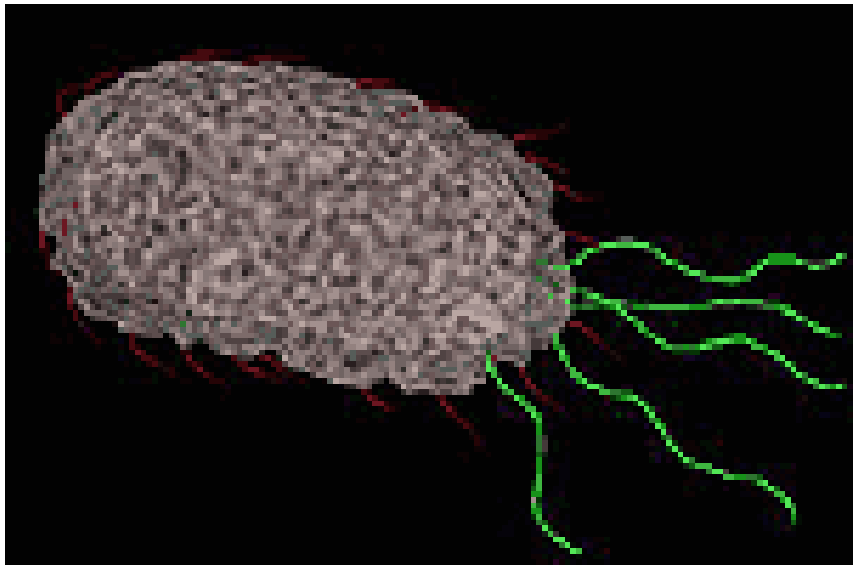




David Malloch, Univ. Toronto

Bacteria That Attack Plants

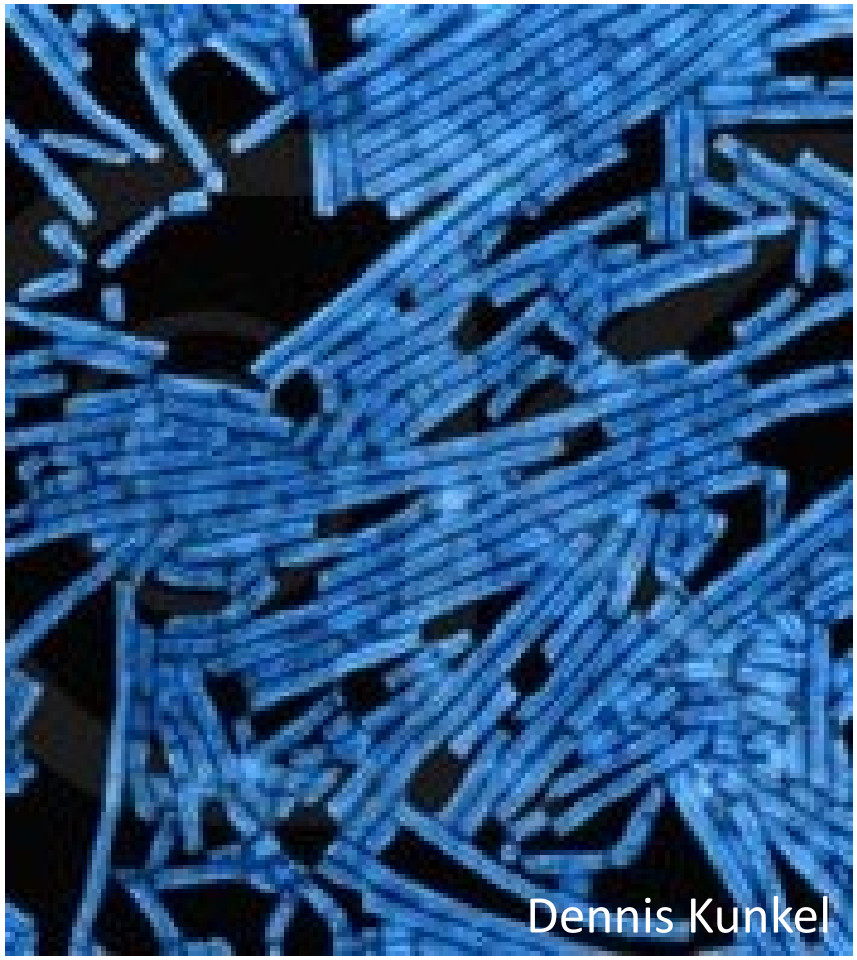
- Tiny (<5 µm) single cells (much smaller than fungi and oomycetes)
- Most bacteria are not pathogens
- Cause spots, blights, wilts and soft rots



http://www.cellsalive.com/cells/3dcell.htm

Viruses & Viroids That Attack Plants

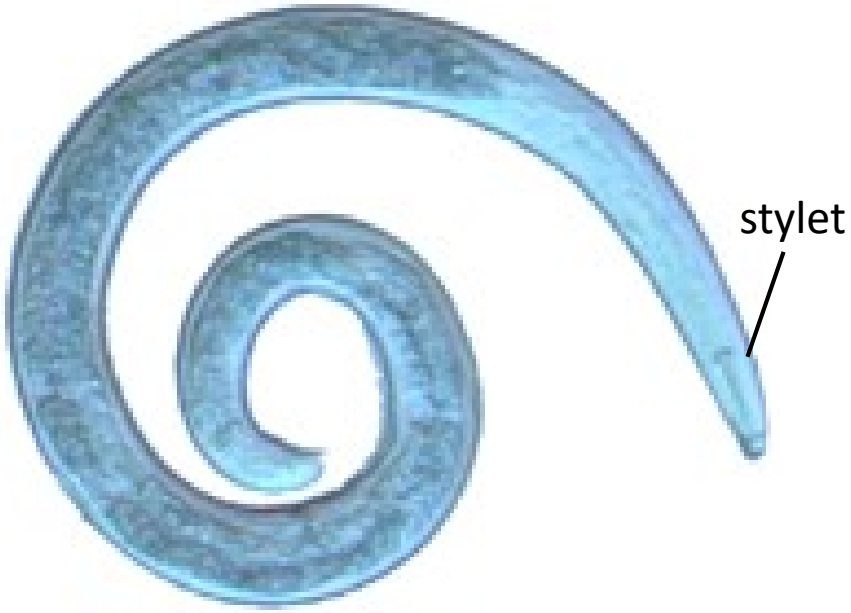
- Viruses are particles consisting of protein plus RNA or DNA
- Viroids are RNA particles
- Moved from plant to plant by insects - "insect transmission"
- Others moved around in plant sap - "sap transmitted"



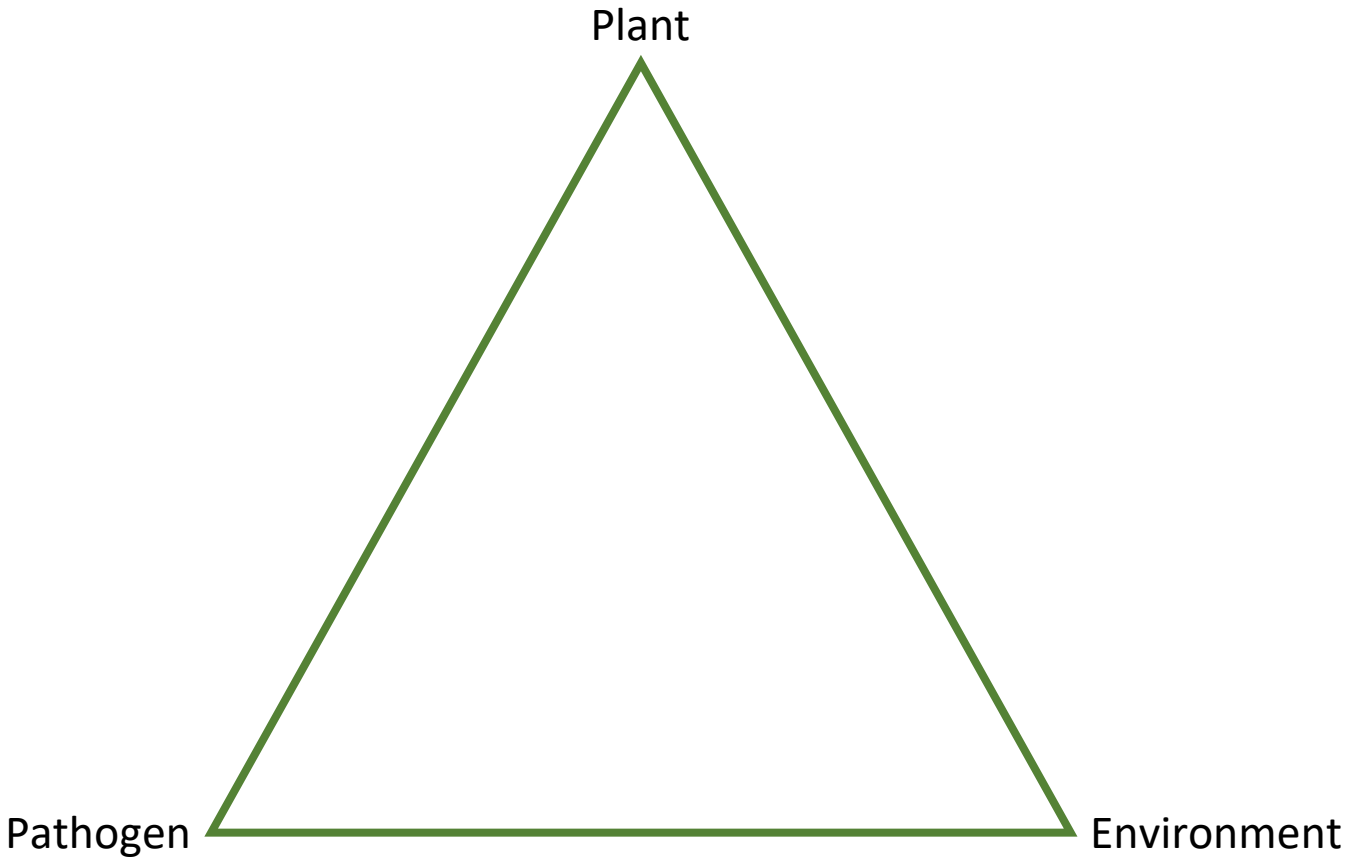
Nematodes That Attack Plants

- Small, wormlike organisms
- Most are not plant pathogens
- Plant pathogenic nematodes have a needle-like stylet to withdraw nutrients from plants
- Have multiple life stages
- All species lay eggs

Helicotylenchus



Plant disease triangle



How to Minimize Plant Disease

- Plant
  - Use genetically resistant plants
  - Reduce plant stress; grow robust plants
    - Provide balanced water and nutrition; appropriate light
- Environment
  - Manipulate environment to favor plant, not pathogen
    - Moisture management; temperature
    - Protected culture!
- Pathogen
  - Avoid pathogen build-up
    - Sanitation, crop rotation, exclusion

Seedborne Diseases - Vegetables

- Not all groups of pathogens or pathogens within a group are seedborne
- Problems vary by crop
- Most common seedborne pathogens of vegetables:
  - Bacteria
  - Viruses
  - Fungi

SOME EXAMPLES OF COMMON SEEDBORNE DISEASES OF VEGETABLES

Septoria Leaf Spot or Blight

- Favored by rainy conditions
- Spots appear on leaves and stems at any stage of plant growth
- Tiny, dark fruiting bodies in lesions
- Plants may lose leaves
- No fruit symptoms
- Also on celery, lettuce, parsley, celeriac

Anthracnose - *Colletotrichum*

- Favored by warm, wet weather
- Symptoms mainly on fruit
- Symptoms may occur on both ripe and green fruit

Seedborne Diseases Caused by Bacteria

- Favored by rainy, humid conditions
  - Temperature optima vary
- Localized or systemic in plants
  - Localized bacteria – external on seed
  - Systemic bacteria – internal in seed
- Affect all above-ground plant parts
  - Systemic bacteria also in roots
  - Fruit infections lead to seed infection/infestation

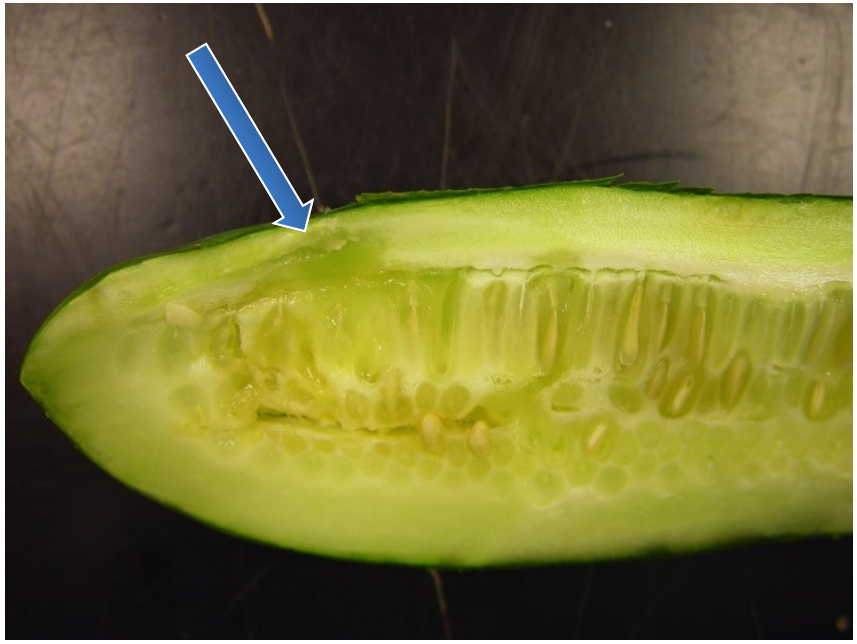
Bacterial Spot


Bacterial Canker


Bacterial Speck

Black Rot of Crucifers

Cucurbit Angular Leaf Spot - *Pseudomonas*



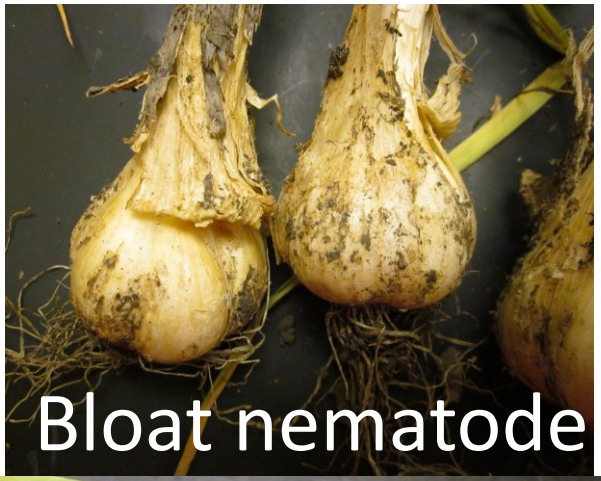
Cucurbit Bacterial Spot - *Xanthomonas*

Seedborne Viruses: Tobacco Mosaic Virus (TMV)

- Affects foliage and fruits
  - Mosaic, leaf distortion, stunting
- Virus very stable – survives a long time (years)
- Mechanically transmitted
- External seed infestation

Bulb-borne diseases

- Major issue in garlic
- Several pathogens are problematic



AVOID COLLECTING SEED FROM DISEASED PLANTS!!!

What do sick plants look like?

Minimizing Seedborne Diseases

- Keep plants healthy
- Scout crop routinely
- If a disease appears, get a diagnosis
  - OSU Vegetable Pathology Lab
  - County Extension office
- Rogue out diseased plants early
- May need fungicide treatments
- Treat seeds with a sanitizing treatment

Seed Treatments

- Clorox treatment very effective for external infestations of any pathogen type
  - Clorox treatment: 25 oz clorox:100 oz water + 1 tsp surfactant for 1 minute, followed by 5 minutes rinse in running tap water
  - Kills bacteria, viruses and fungi on seed surface
  - May not kill internal pathogens
- If organic, check with certifier for chlorine use

Seed Treatment with Hot Water

- Kills internal and external plant pathogenic bacteria
  - Does not kill plant pathogenic viruses or fungi
  - Does not kill human pathogens
- Allowed in organic systems

- We now recommend following hot water treatment with Clorox treatment if feasible

Water Bath Temperatures and Treatment Times

Seed	°F	Minutes
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	25
Broccoli, cauliflower, cucumber*, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	20
Mustard, cress, radish	122	15
Pepper	125	30
Lettuce, celery, celeriac	118	30

* Cucurbit seeds may be damaged by hot water treatment

HYG-3085-05

THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

Plant Pathology, 2021 Coffey Road, Columbus, Ohio 43210

Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens

Sally A. Miller

Melanie L. Lewis Ivey

One of the ways plant pathogens are introduced into a crop is on seeds. Bacterial pathogens are particularly notorious for this means of dissemination. In general, the earlier a pathogen comes in contact with the crop, the greater the potential for a serious disease problem to develop. This is why it is very important to start with "clean" seed. Clean seed can be obtained by applying one of the treatments described below to kill bacterial pathogens on and/or within the seed.

When treating vegetable seeds it is critical to follow the instructions exactly, as seeds may be damaged by the treatment and/or the pathogen may not be completely eliminated. In addition, old or poor quality seed can be injured by seed treatments. **Therefore, it is recommended that a small sample be treated and tested for germination (see method below) prior to treating the entire seed lot.** Treatments should be done on raw seed only, since the treatment will destroy any seed pelleting and will wash off any fungicide that may have been applied to the seed. If fungicide treated seeds are used, the fungicide washed off must be disposed of properly. After the treatment, seed may be treated with Thiram to prevent damping-off caused by various soilborne fungi.

Hot Water Treatment

Properly used, hot water treatment kills most bacterial disease-causing organisms on or within seed. This treatment is suggested for seeds of eggplant, pepper, tomato, carrot, spinach, lettuce, celery, cabbage, turnip, radish, and other crucifers. **Seeds of cucurbits (squash, gourds, pumpkins, watermelons, etc.) can be damaged by hot water and thus should not be treated.**

Instructions

A. The following equipment and supplies are needed to hot water treat vegetable seed.

- Water bath (preferably two: one for pre-warming and one for treatment; Sources: Fisher Scientific Co., Thomas Scientific, VWR Scientific)
- Thermometer
- Cotton cloth, cotton bags, or nylon bags
- Screen for seed drying

HYG-3085-05

We are in the process of updating this factsheet

Will be posted on u.osu.edu/vegetablediseasefacts/

Dry heat treatment

- Still experimental
- Effective against viruses, fungi, and bacteria
- Watch for more information, no factsheets currently available

HCl treatment of tomato seeds

- Effective against seedborne viruses and bacterial diseases

Directions (from Dr. Melanie Ivey, OSU)

1. Prepare a 5% solution of HCl by adding one part acid to 19 parts potable water. Prepare the acid solution in a well ventilated area and avoid direct skin contact with the acid.

2. Soak seeds for 6 hours with gentle agitation.

3. Carefully drain the acid off of the seed and rinse seed under running potable water for 30 minutes. Alternatively, rinse the seeds 10-12 times with potable water to remove residual acid.

4. Spread seeds evenly on clean paper towel or a sanitized drying screen to dry. Do not dry seed in area where fungicides, pesticides, or other chemicals are located.

5. Seed can be treated with a labeled fungicide to protect against damping-off pathogens.

http://www.lsuagcenter.com/NR/rdonlyres/26772246-4C4A-4028-992D-95BF6DD51C6D/96988/43SeedTreatmentsVegetables2014FINAL.pdf

TSP treatment of tomato seeds

- Used to eradicate seedborne TMV

Directions (From Dr. Melanie Ivey, OSU)

1. Prepare a 10% solution of TSP (1 part TSP in 9 parts potable water). Trisodium phosphate is available at most home supply or paint stores. Avoid direct skin contact with the TSP solution.
2. Soak seed for 15 minutes in the disinfectant solution.
3. Rinse the seed in a cold water bath for 5 minutes to remove residual disinfectant.
4. Spread seeds evenly on clean paper towel or a sanitized drying screen to dry. Do not dry seed in area where fungicides, pesticides, or other chemicals are located.
5. Seed can be treated with a labeled fungicide to protect against damping-off pathogens.

http://www.lsuagcenter.com/NR/rdonlyres/26772246-4C4A-4028-992D-95BF6DD51C6D/96988/43SeedTreatmentsVegetables2014FINAL.pdf

How to Test Seed Germination

- Mix seeds in each seed lot and count out 50 seeds per seed lot
- Hot water- or Clorox-treat 1/2 of the seeds exactly as described
- After treated seeds have dried, plant the two groups of seeds separately in flats containing planting mix
- Allow the seeds to germinate and grow until the first true leaf appears

Testing Seed Germination……

- Count seedlings in each group separately
- Determine the % germination in each group

$$\frac{\text{\# seedlings emerged}}{\text{\# seeds planted}} \times 100$$

- Compare % germination in each group
  - should be within 5% of each other

Seed Treatment Cautions

- Use new, high quality seed
- Treat a small sample first and test for germination
- Treat close to time of planting or distribution (within weeks)
- Treat only once

For More Information on Vegetable Diseases and Management

- Ohio Veggie Disease News
  - u.osu.edu/miller.769
- Vegetable Disease Facts
  - u.osu.edu/vegetablediseasefacts/
- VegNet Newsletter
  - u.osu.edu/vegnetnews
- Twitter
  - @OhioVeggieDoc