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THE STATE UNIVERSITY OF NEW JERSEY

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New Jersey Agricultural Experiment Station
COOPERATIVE EXTENSION
CUMBERLAND COUNTY

Phytophthora *(and other bad guys)*
Detection & non-chemical approaches

Timothy J. Waller, PhD
Cumberland RCE – Nursery Crops

UMD Biocontrol Conference 2024

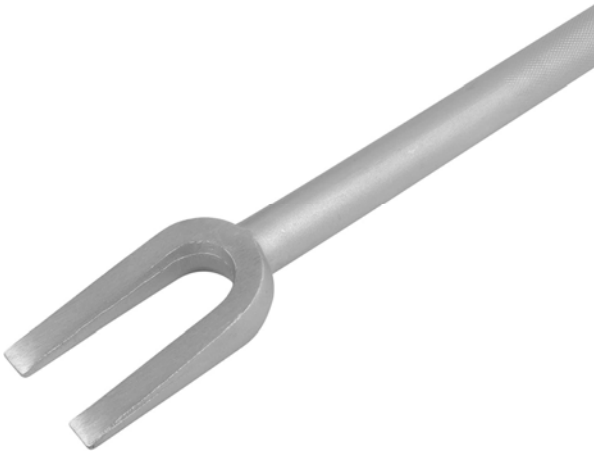
6/6/2024 2:40 – 3:20pm

We need the
toolbox

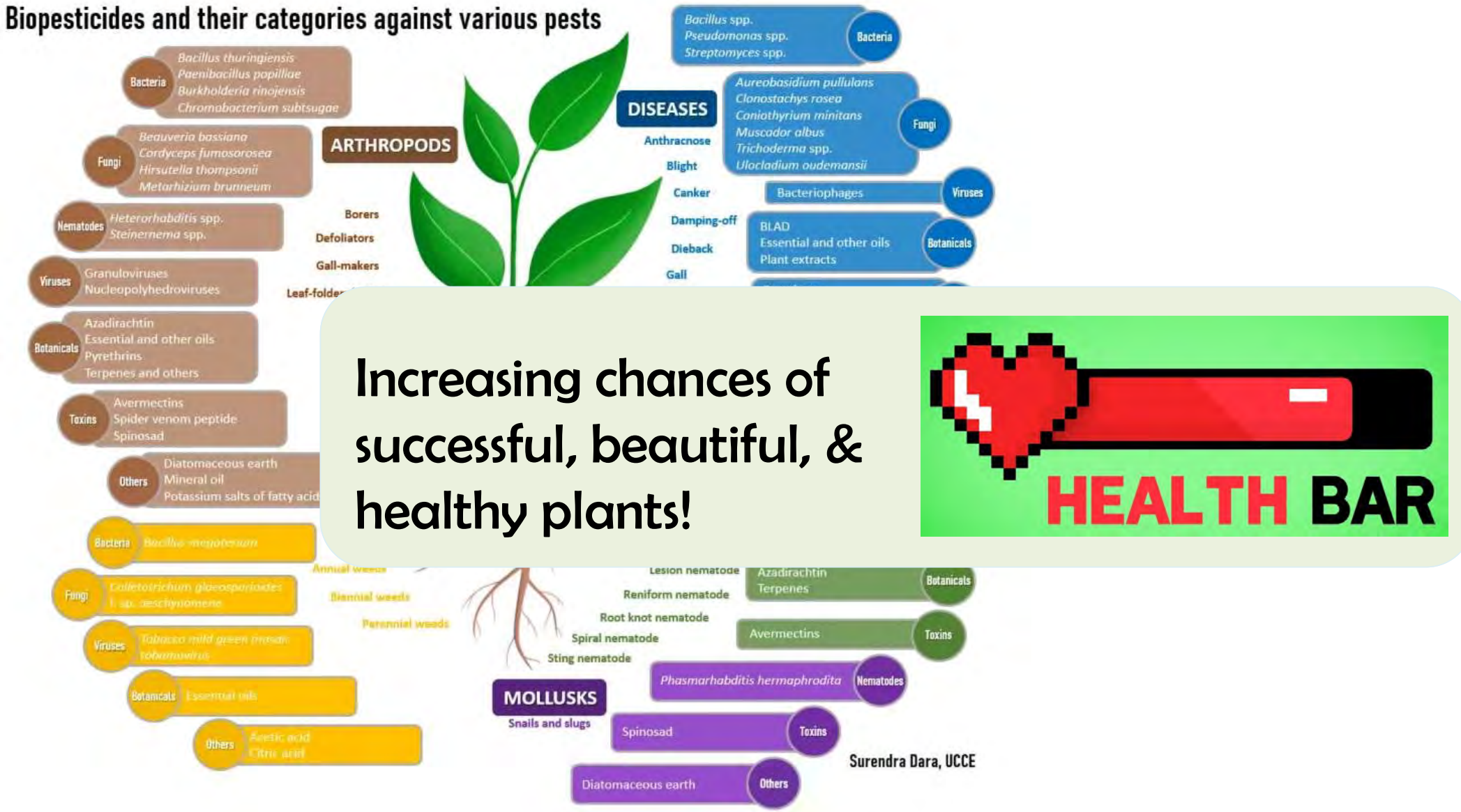
Pesticides are
one tool

Don’t get you
very far alone

sometimes…



Need a
special tool



Increasing chances of successful, beautiful, & healthy plants!

For all root diseases!

Cultural > Chemical

Persistent survival structures (decades)

Often hard to effectively treat entire rhizosphere

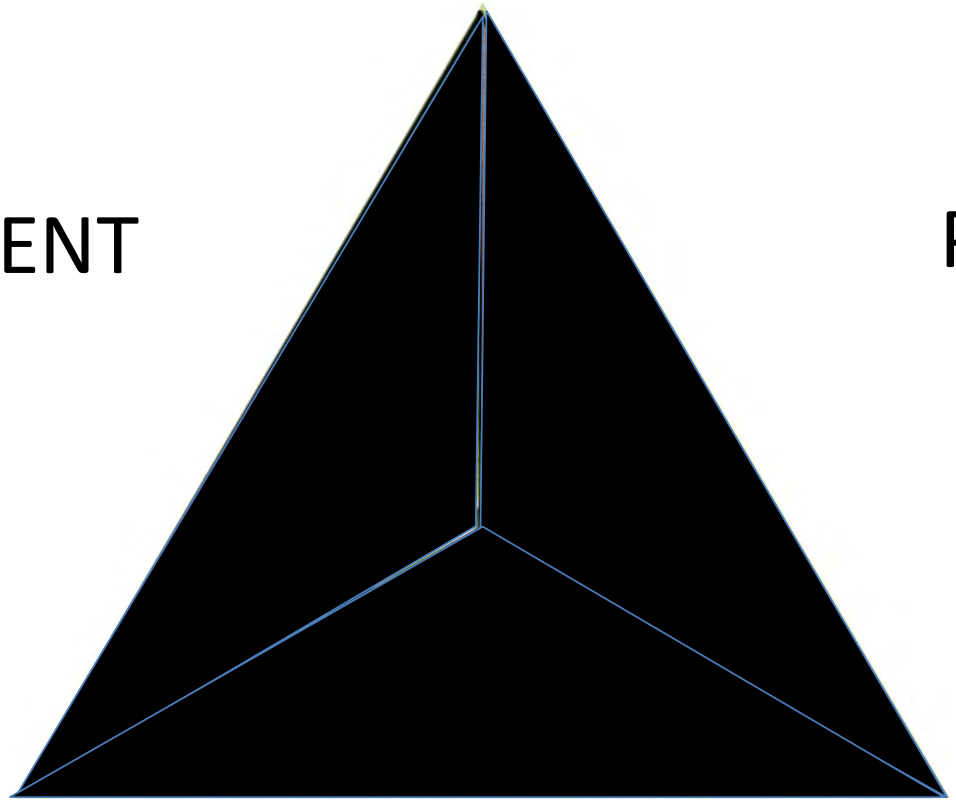
Follow the water = find the disease (trt efforts)

Disease Triangle – *presence of disease*

Primer

ENVIRONMENT

PATHOGEN

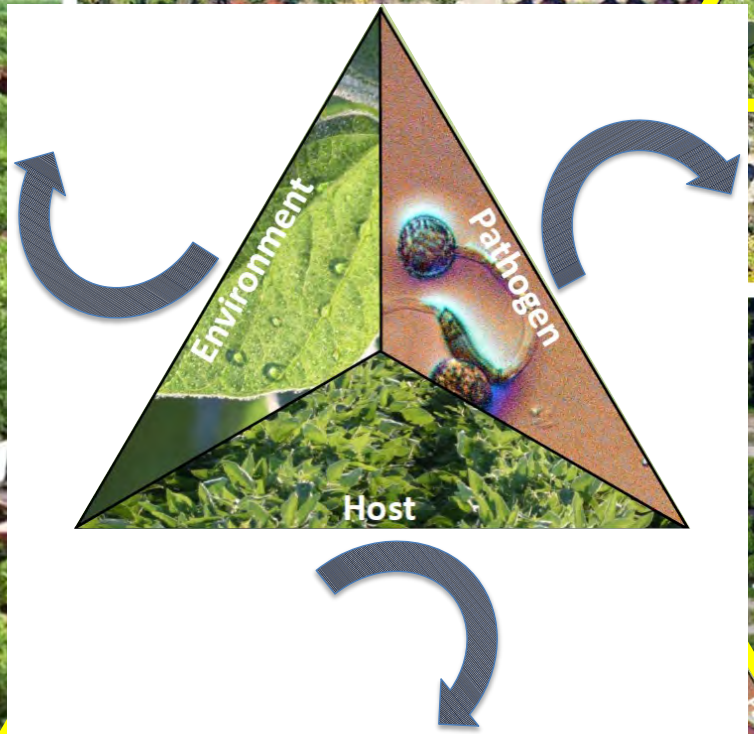


HOST PLANT

MANY concurrent timescales

Primer

Same game



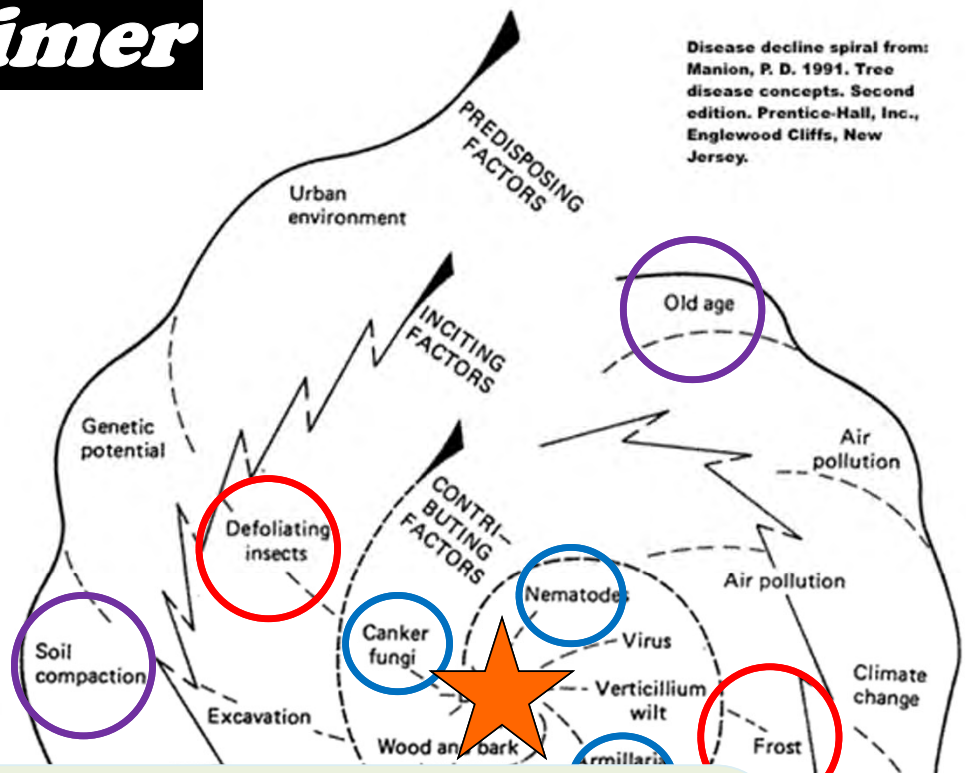
Different players!

RUTGERS **Primer**

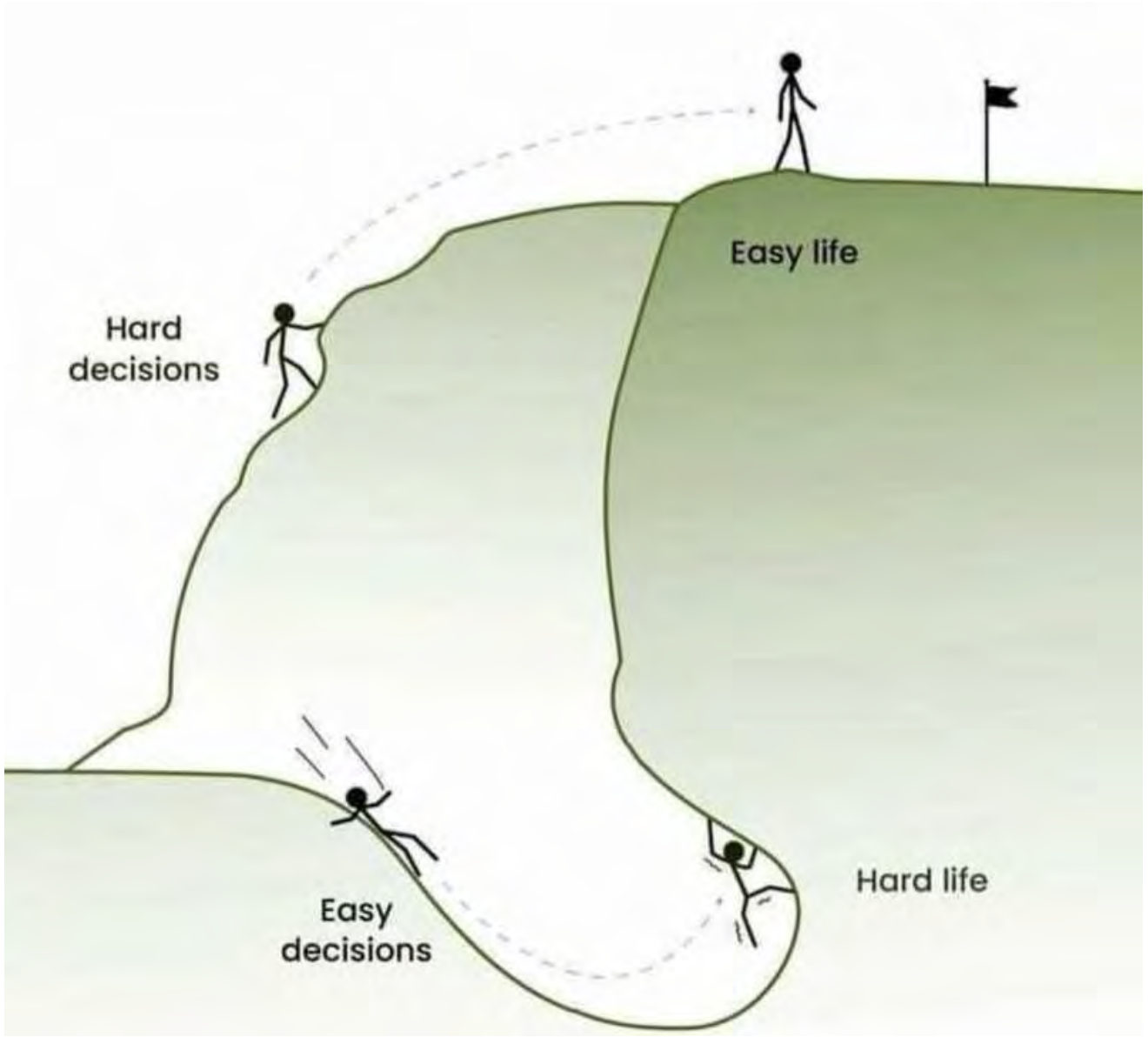
Plants are constantly under attack!

Decline or death due to **many stressors**

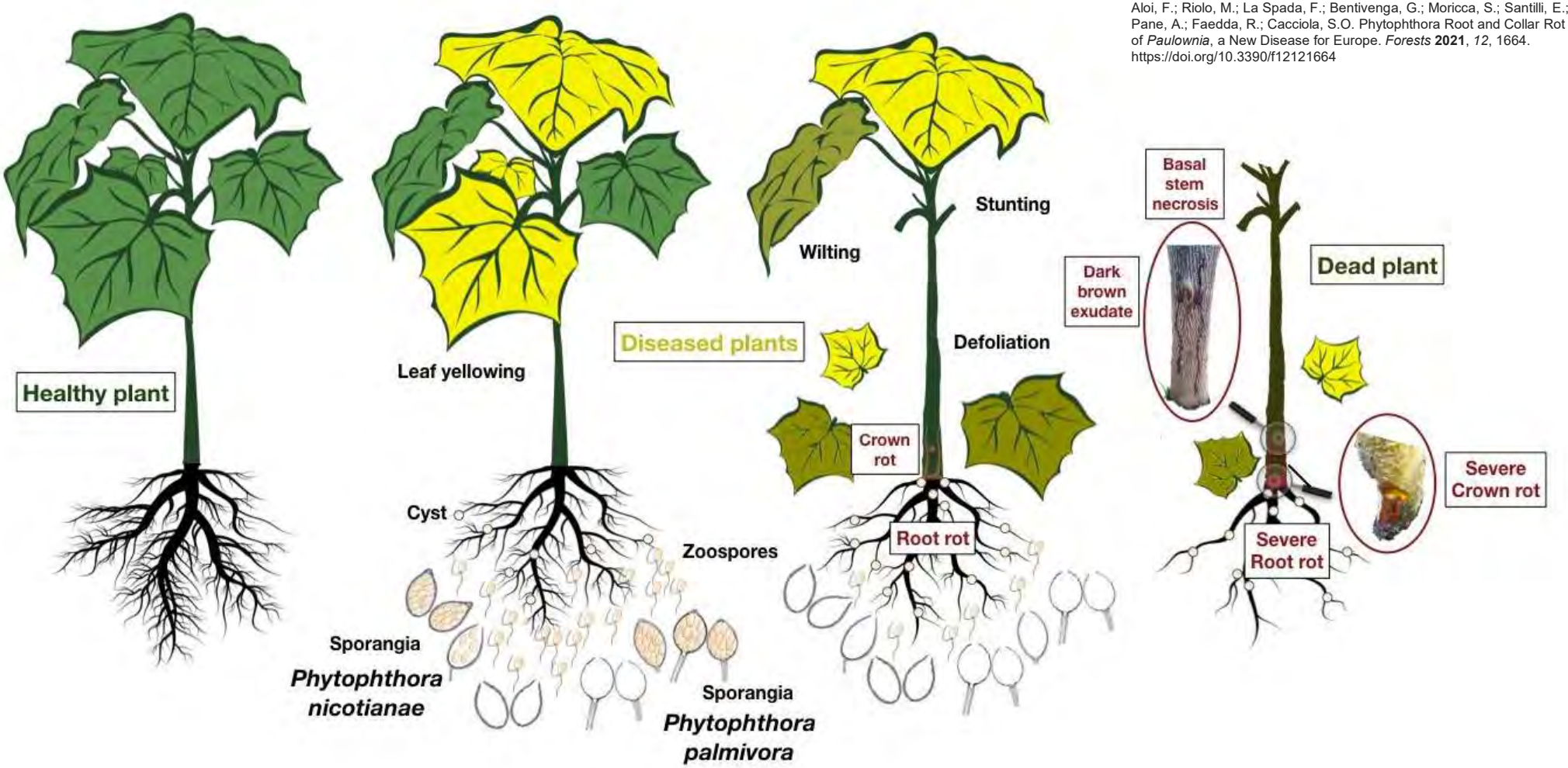
- The opportunistic pathogen wins out
- *We blame the pathogen*, not the stress



Think of plants as video game characters


Easy life
Hard decisions
Easy decisions
Hard life

REMEMBER - We are talking about biology



Aloi, F.; Riolo, M.; La Spada, F.; Bentivenga, G.; Moricca, S.; Santilli, E.; Pane, A.; Faedda, R.; Cacciola, S.O. Phytophthora Root and Collar Rot of *Paulownia*, a New Disease for Europe. *Forests* **2021**, *12*, 1664. https://doi.org/10.3390/f12121664

Destroys plant's ability to gather resources = **major plumbing problems**

Most root / crown diseases mimic

Water / Drought

Nutritional

Phytotoxicity / Abiotic

Because the plant simply **cannot get the resources**
Or whole areas of **dissimilar** plants affected

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What are we up against?

Use your diagnostic labs!

Physiological / nutritional	Pest or mechanical	Disease

If you get this wrong = negative impacts

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What is Phytophthora

What are the Oomycetes

Detection & Diagnostics

Oomycete root disease causal agents in horticulture

Pythium

Phytopythium

Phytophthora

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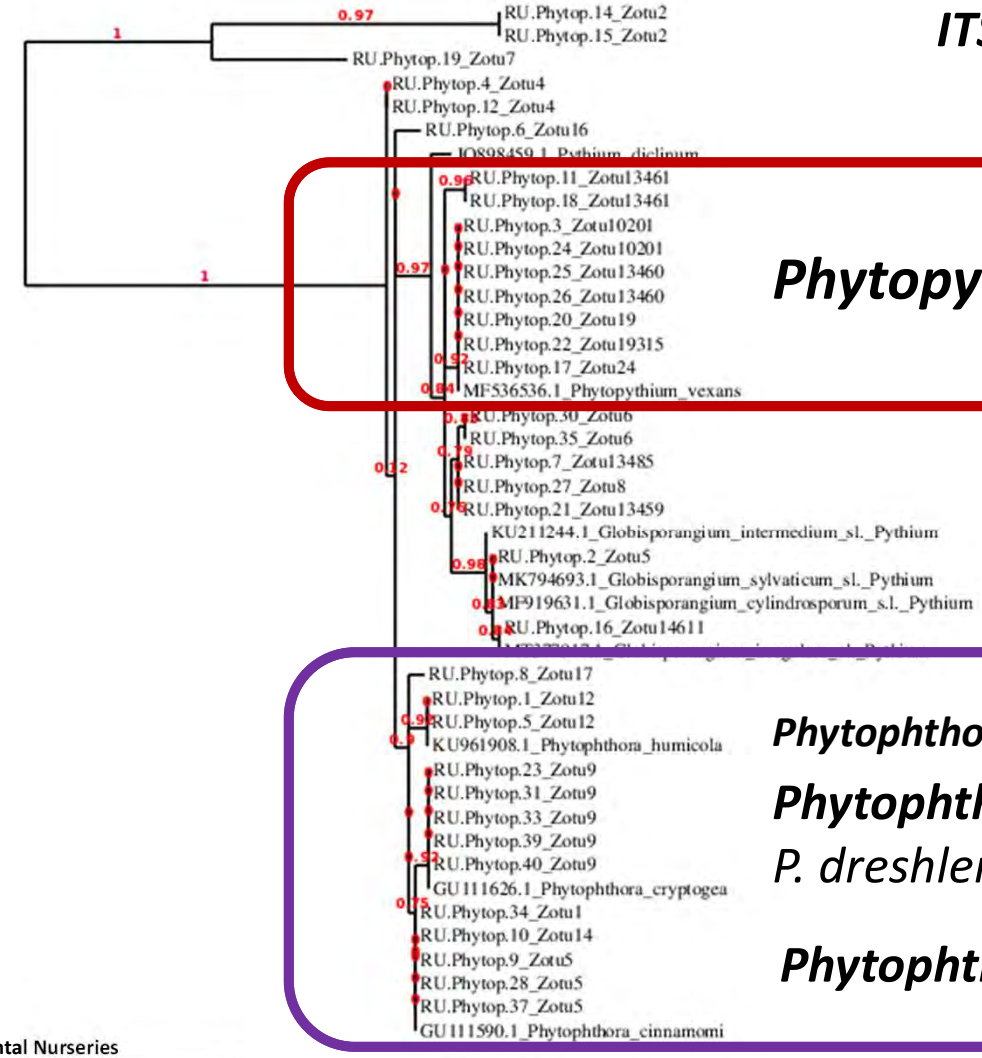
Species detected – *first round bioinformatics*

ITS gene (3 more to do)

Speciation of New Jersey isolates from Christmas Tree and Ornamental Nurseries



Phytopythium vexans

Pythium spp.

Phytophthora *humicola*

Phytophthora *cryptogea /*
P. dreshleri

Phytophthora *cinnamomi*

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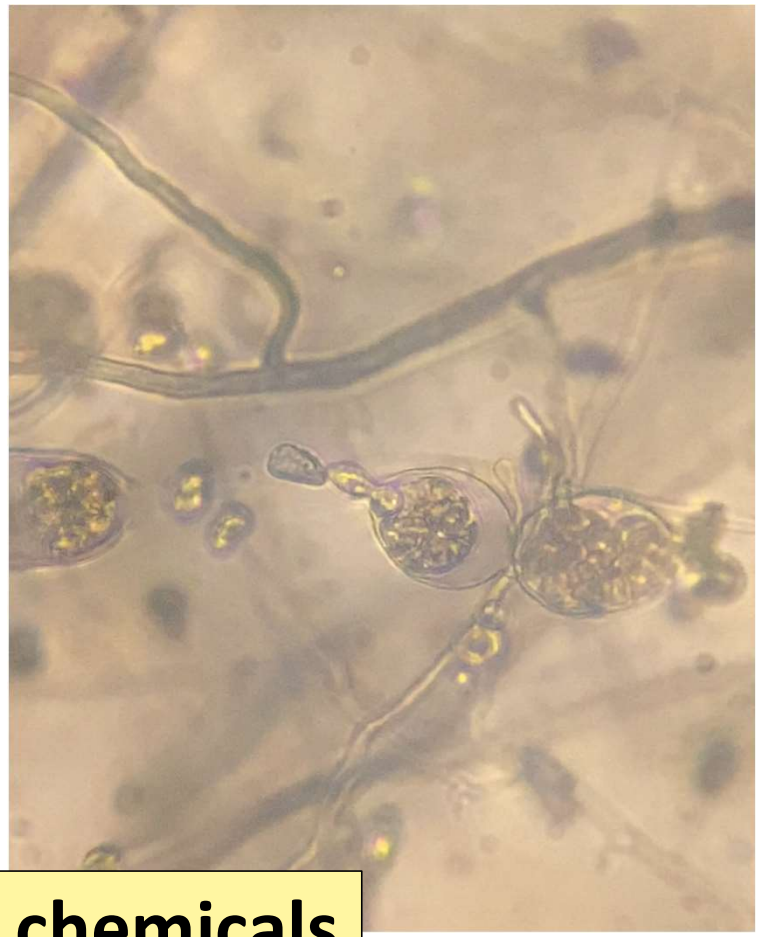
Oomycetes aka. the water molds

Oomycetes:

Phytophthora, Pythium, Phytopythium, Downy mildew

- All but Downy Mildews typically destroy / infect root systems
- **These are NOT fungi****
- …but called ‘water molds’
- Cell walls are *cellulose* based, not chitin based like fungi & insects



Generally need **Oomycete specific chemicals

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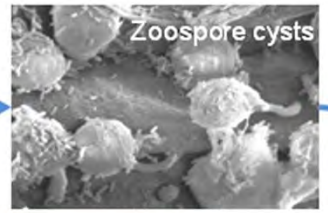
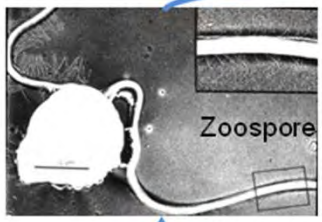
Oomycetes have dynamic life cycles

Seek out roots / 'swim' to them

Zoospores

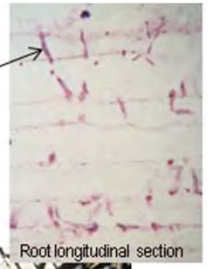
Zoospores encyst and infect roots





Rapid disease cycling under wet conditions

Hyphae invade and kill root tissues



Direct infection by chlamydospores

Sporangia release swimming zoospores

Sporangia

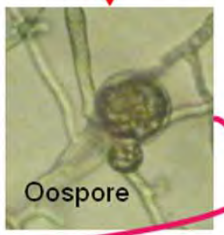
Spread in soils, equipment, seedlings

Sporangia form on infected roots

Survival and dispersal under dry conditions

Resistant structures form in or on infected roots

Chlamydospores



2x Bullet-proof survival structures *(years)*

Oospores

Resistant spore germinates to form a sporangium

***Phytophthora* root rot Disease Cycle**

http://phytosphere.com/soilphytophthora/Phytophthora_and_nurseries.htm

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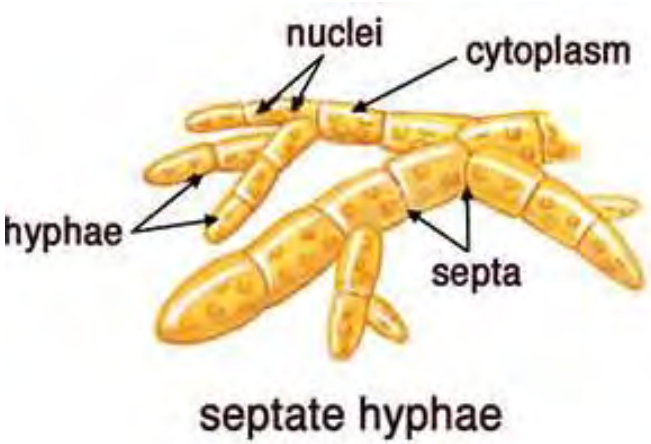
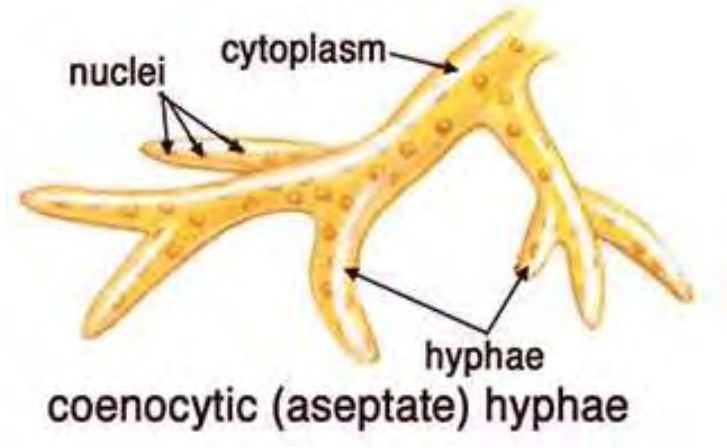
Oomycetes are NOT FUNGI



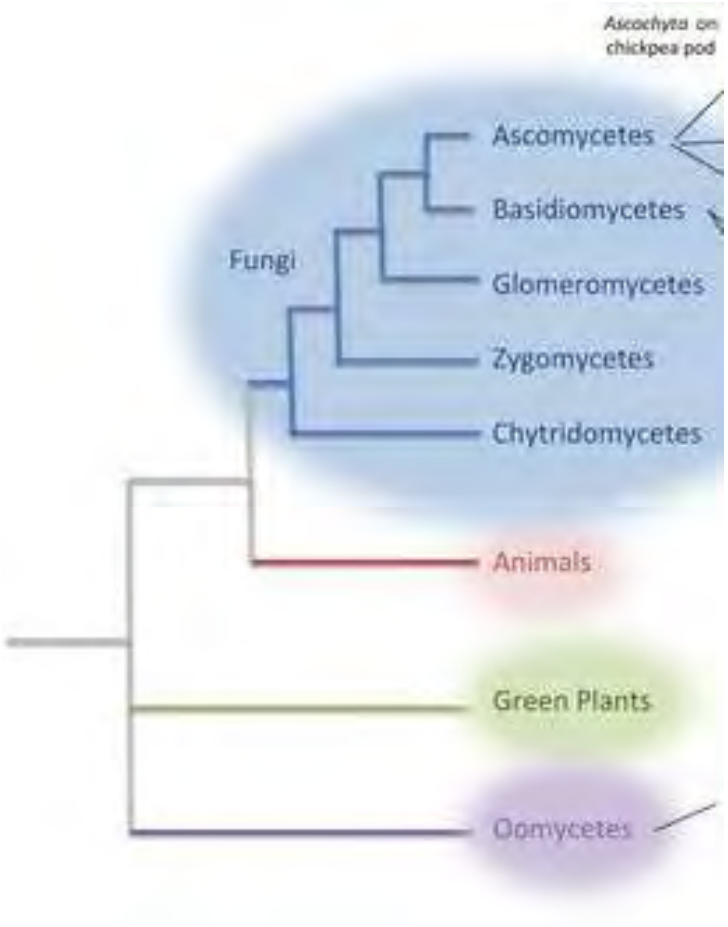
septate hyphae



coenocytic (aseptate) hyphae

Virtually all fungi have **septations**

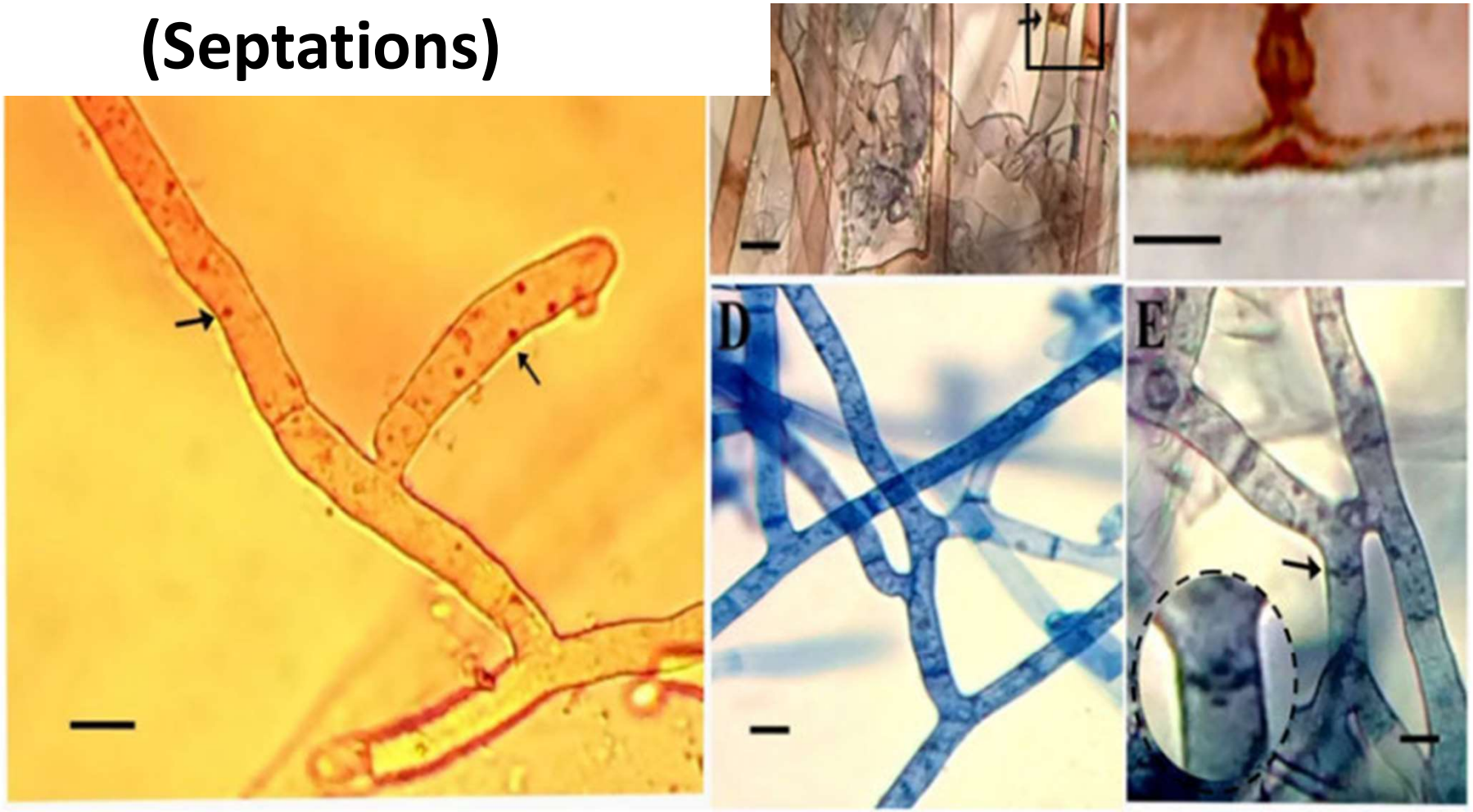
Oomycetes = **Aseptate**



https://thebiologynotes.com/fungal-structure/

Fungal evolutionary genomics provides insight into the mechanisms of adaptive divergence in eukaryotes (2013). Molecular ecology. 23.10.1111/mec.12631

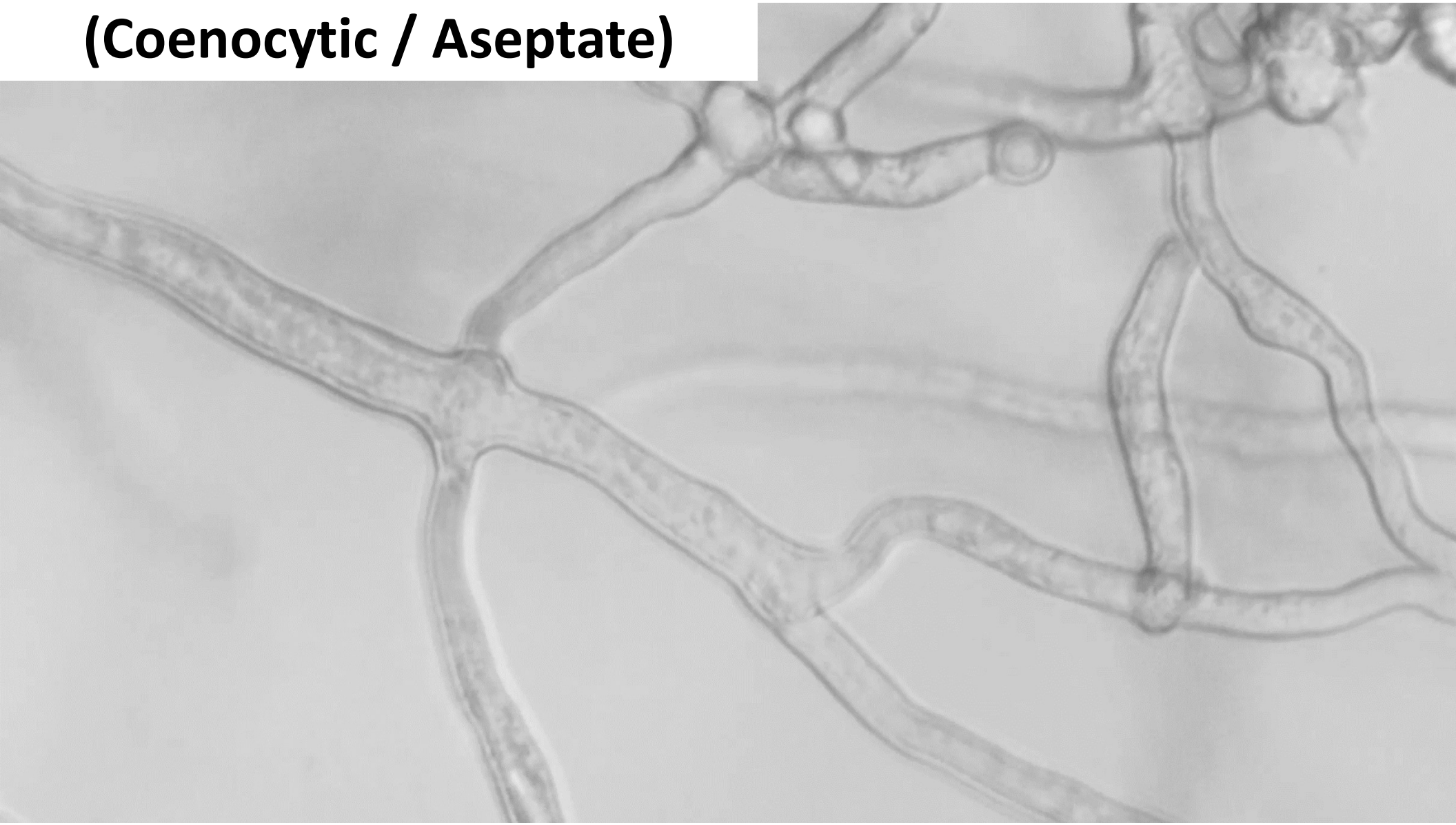
(Septations)



Hyphal characteristics of Rhizoctonia solani, (A) right angle, Foot cell with restriction, multinucleate cells. (B) Dolipore septa. (C) Magnified area of image B. (D) Transfer of the cell content to neighbor cell. (E) Anastomosis and creation of heterokaryons. Bar ¼10 mm (A, B, D and E) and 5 mm (C).

Elshafey, R. & Elamawi, Rabab & Saleh, Mona & Tahoon, Abdelaziz & Emeran, Amero. (2019). Morphological, pathological and molecular characterisation of rice sheath blight disease causal organism Rhizoctonia solani AG-1 IA in Egypt. Archives of Phytopathology and Plant Protection. 52. 1-23. 10.1080/03235408.2019.1650544.

(Coenocytic / Aseptate)



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Phytophthora symptoms

Slow decline **or** rapidly apparent death

Leaves / Needles – turn straw, cinnamon brown *(stay on), curl*

Branches – Single, groups, all, discoloration starting near crown

Stem – Cankers, wood dark streaks, bark pulling away

Resembles drought stress – *watering makes it worse*

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Oomycete root symptoms

- **Often no root hairs** / thick roots
- **Dark discoloration**
- **Outer root tissue sloughs off easily**
  - **'Sheath pulls off easily"**
  - **AKA 'Rat tail'**
- Sunken cankers on roots
- ***Dig around*** *– if you pull sapling the diagnostic roots will pull off*
- Brittle, break easily

Agdia ImmunoStrip® for Phytophthora (Phyt)

Click to view a larger image

Overview | Included Items | Technical Information | Documents

The *Phytophthora* (*Phyt*) ImmunoStrip® is used to detect the presence of *Phytophthora* species in many crops including Oak, Potato, and Strawberry. ImmunoStrips® are the perfect screening tool for use in the field, greenhouse, and the lab.

This test is recommended for use as a preliminary screening tool in survey programs for *Phytophthora* species such as *P. ramorum* (Sudden Oak Death) and *P. kernoviae*. The test is also suitable for detection of *Phytophthora* species that affect other important crops such as *P. fragariae* in strawberry or *P. infestans* in potato.

The *Phyt* ImmunoStrip® detects *Phytophthora* to the genus level and cannot differentiate species. For a full list of species that have experimentally detected **click here**.

Click here for other product documents such as the **User Guide** or **Validation Report**.

☐	ImmunoStrip® for Phytophthora (Phyt), 5 strips and buffer filled bags ISK 92601/0005	$75.00/EA	1 Buy
☐	ImmunoStrip® for Phytophthora (Phyt), 25 strips and buffer filled bags ISK 92601/0025	$185.00/EA	1 Buy

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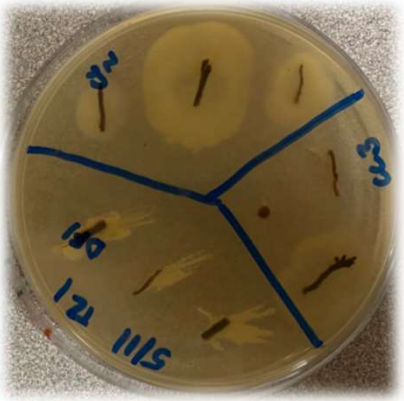
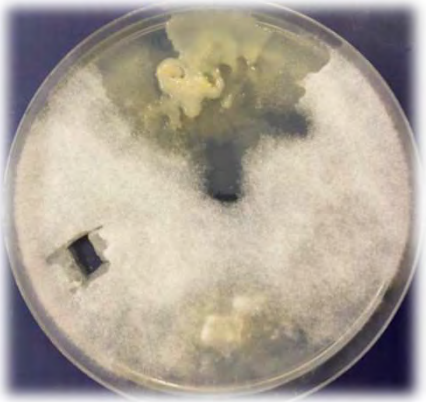
Sampling

Locate

Dig

Samples





Selective media isolations

Diagnostic morphology

Sequencing (to species)

This approach helped us find new host:pathogens

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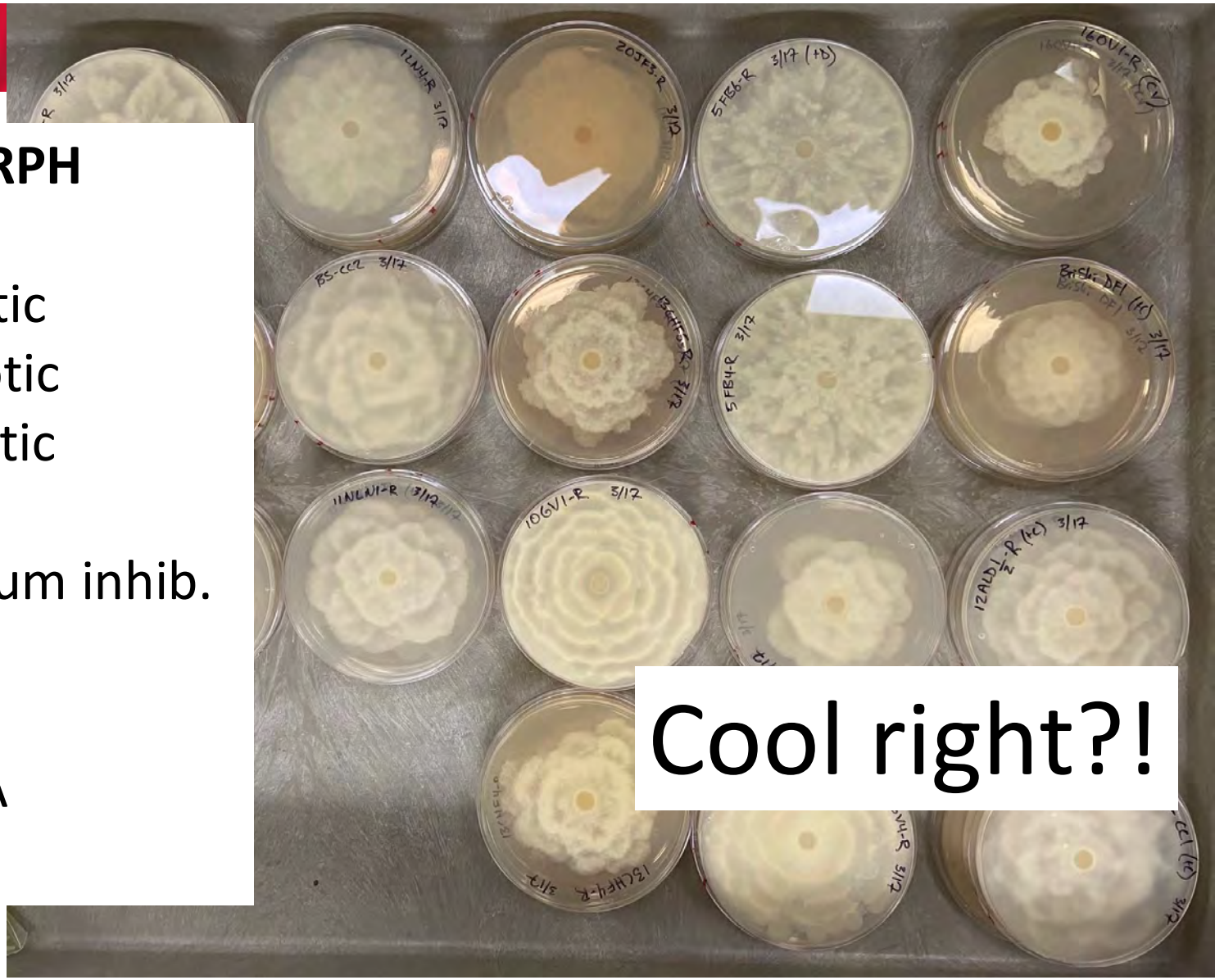
Selective Media - PARPH

- CM or clV8 Agar
- **P**imaricin - antibiotic
- **A**mpicillin - antibiotic
- **R**ifamycin - antibiotic
- **P**CNB - fungicide
- **H**ymexazol – Pythium inhib.

Culture Medias

PDA, clV8A, CMA, WA

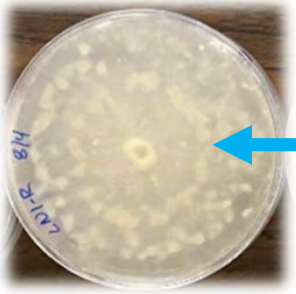


Off-site sampling

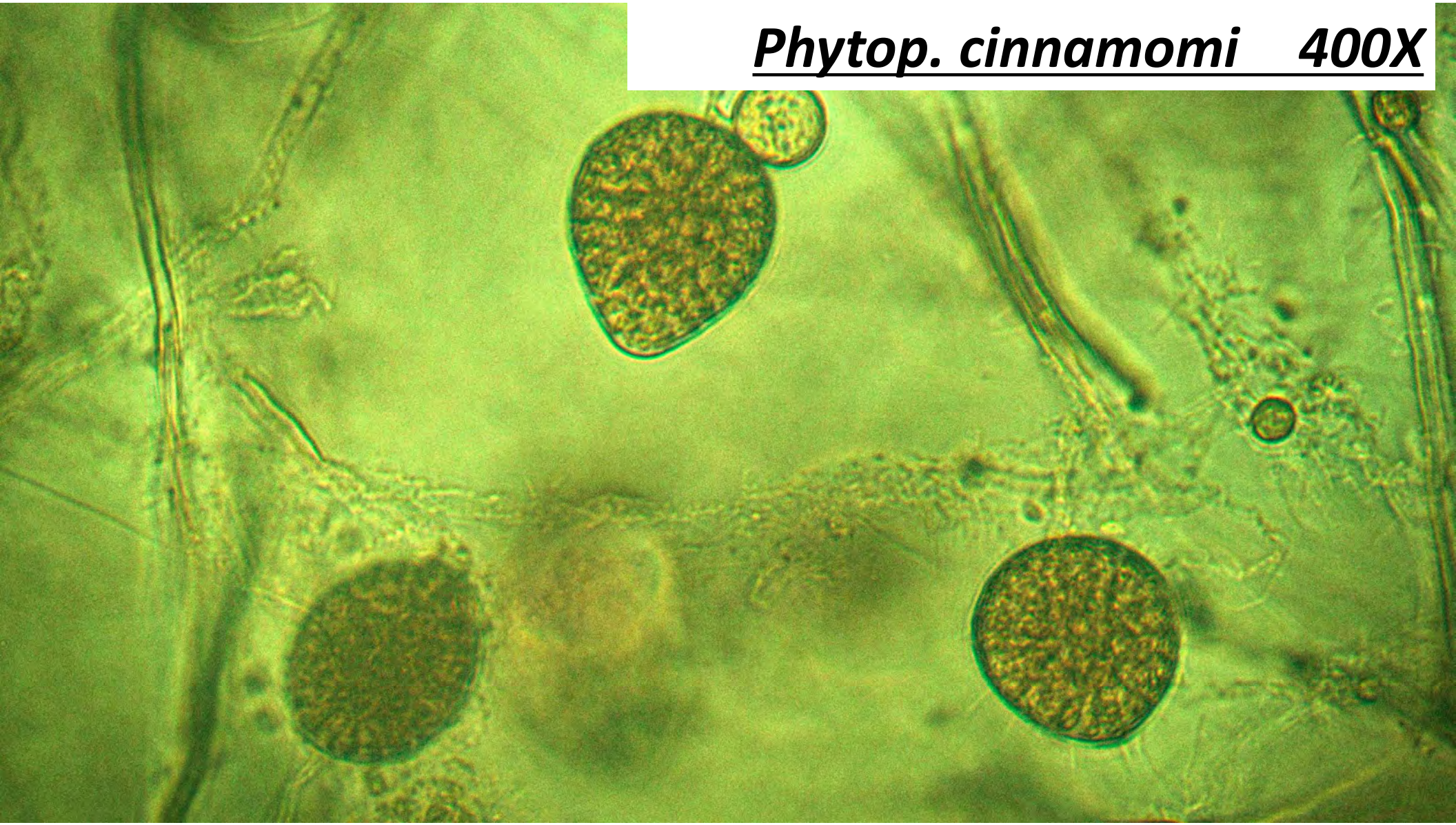
Aerated growth chamber

Off-site Water
(natural, irrg.)

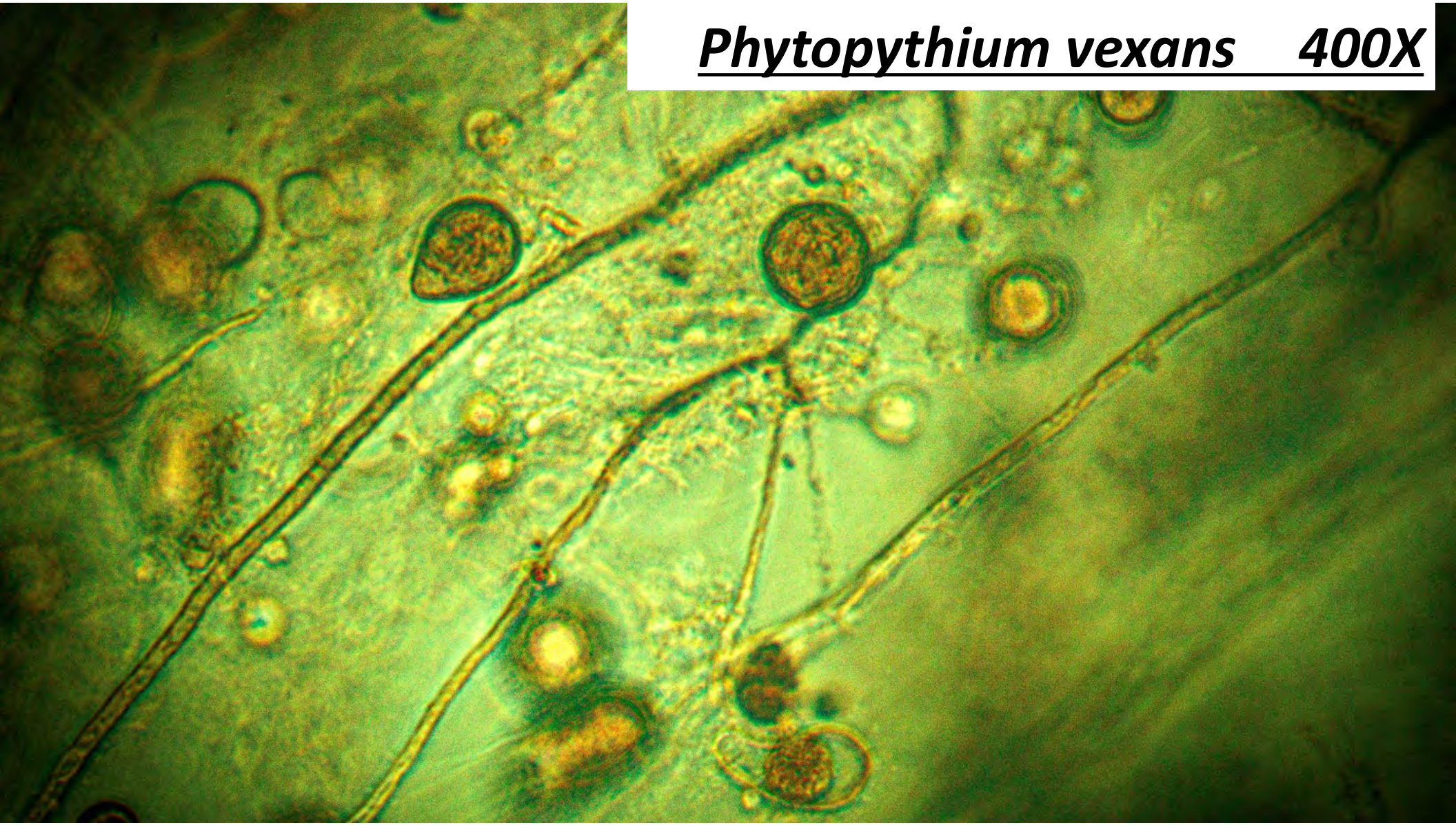
Off-site soil
(slurry)



“Baits”



Phytop. cinnamomi 400X



Phytopythium vexans ***400X***

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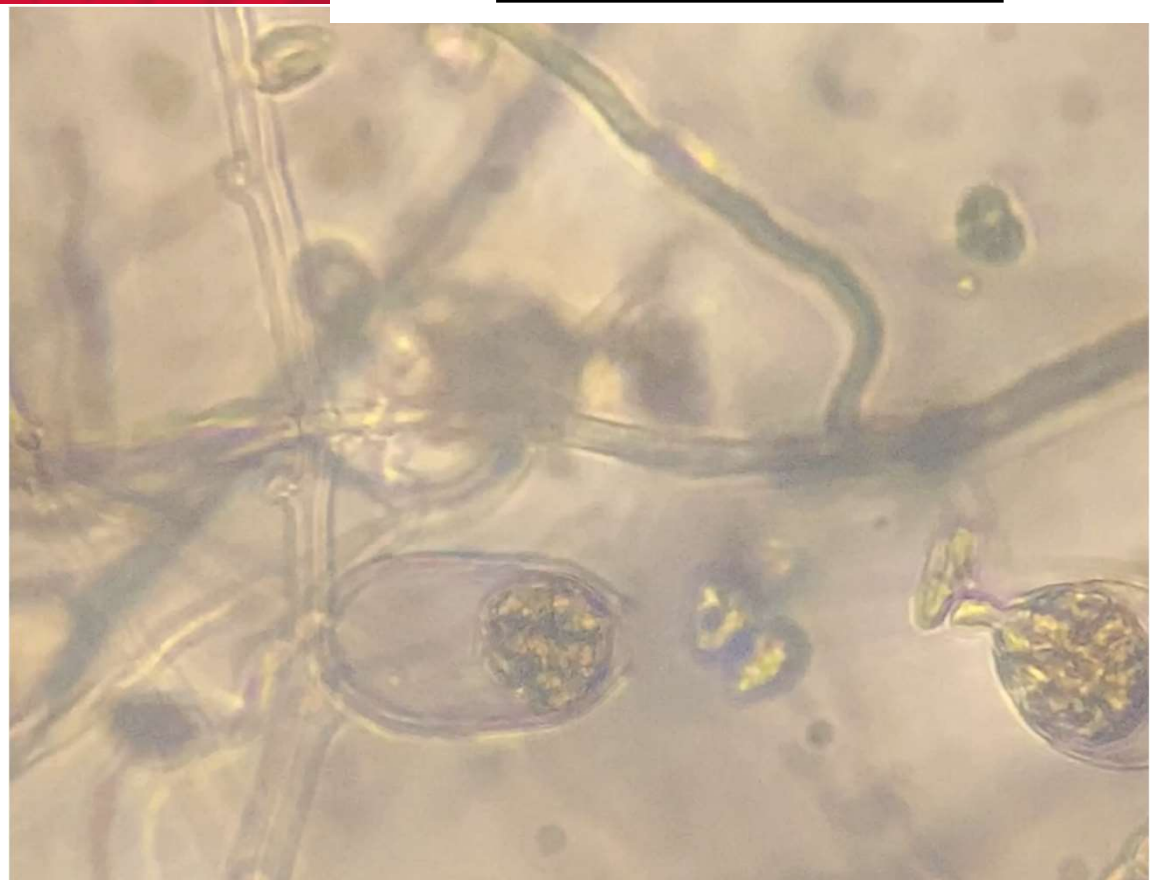
P. cinnamomi zoospore release



They also have swimming spores called – **zoospores = root seeking missiles! Chemotaxis – movement towards root signals**


Problems?


Problems?

Irrigation

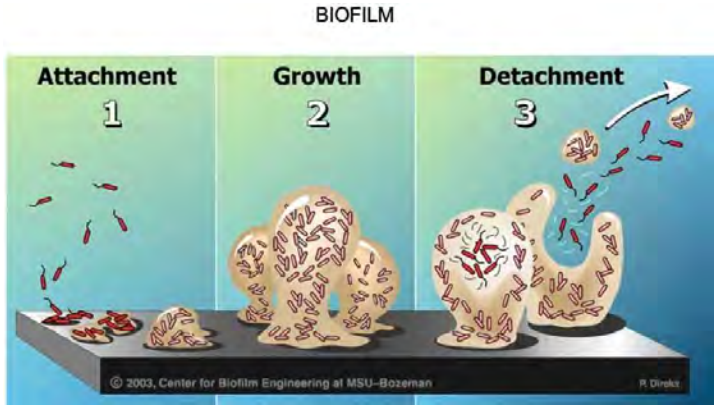
Water treatment

- Physical filtration of water
- Critical in recycled systems
- Chlorine, bromine, some Quats (like KleenGrow), UV , Copper ionization treatment
- Testing – active sanitizer levels throughout system

Irrigation infrastructure maintenance

- Cleaning and sanitizing pipes
- Biofilm accumulation – clogging
- Spread / harbor diseases / algae
- Oomycetes / water-molds major threat

https://www.nurserymag.com/article/nm0315-recycling-irrigation-water-tips/



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Sand filtration – mechanical avoidance

https://www.plantsciences.ucdavis.edu/news/sand-filters-eliminate-pathogens-irrigation-water

https://www.berryhilldrip.com/SAND-FILTER-ASSEMBLIES-Fiberglass-TRITON-Sets-are-used-for-filtering-dirty-water-pond-stream-river-lake-water-..html

Avoiding: Phytophthora, Pythium, Rhizoctonia, Fusarium

Not always 100% effective…but a great start

For every plant on the planet there is a **small number** of possible pests or diseases

Accurate ID + Key Pest/Disease = High likelihood of solved issue

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What are we up against?

Use your diagnostic labs!

Physiological / nutritional

Pest or mechanical

Disease

If you get this wrong = huge implications

#1 Management tool for Oomycetes

ENVIRONMENT

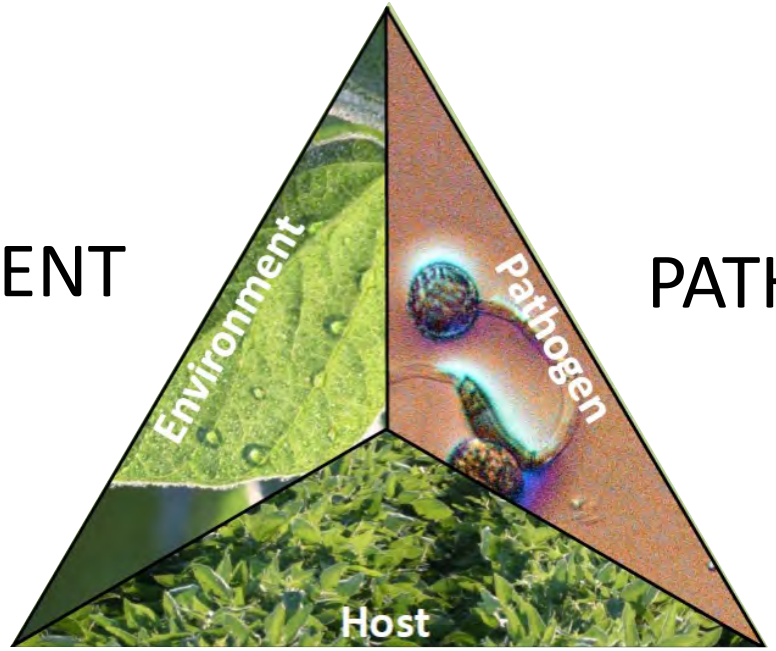
Water management

Air flow

Pesticides / biologicals

Reduce abiotic stress

Plant location



PATHOGEN

Causal agent / ID

Host specificity

Lifecycle / hide-outs

Favored conditions

HOST PLANT

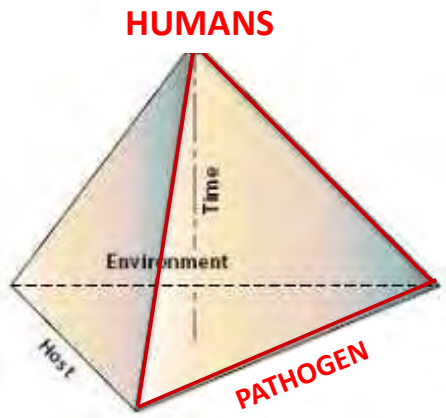
Susceptibility / Resistance

Reduce other stressors (like insects / abiotic)

Plant rotations

Principals of Plant Pathology….but generally applicable here

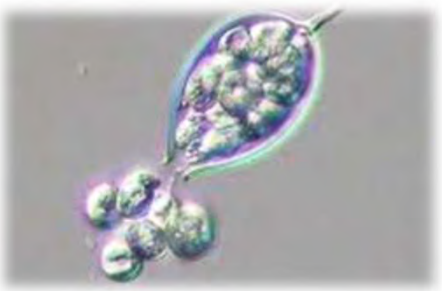
1. **Avoidance:** selecting a site with no known disease or a non-conducive site
2. **Exclusion:** prevent the introduction of pathogens
3. **Eradication:** eliminate, destroy, or otherwise inactivate
4. **Protection:** prevent infections by means of toxicant or barrier
5. **Therapy:** cure plants already infected (doesn't really work!)












Surfaces / Substrates Tools / Equipment Irrigation systems Plants & People

Identify control points in YOUR systems

Cleanliness *is key* – Sanitation *is sanctity*

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I know what cleaning is…

- ALWAYS DONE FIRST

- **Whole idea = remove organic matter**
  - Plant tissues, soil, bark, biofilms, etc.

- **Removal via physical** / mechanical
  - **Power-washer**, hose, brushes, chisels

- **With a detergent + water**
  - Detergent / degreaser is not always a sterilant

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So, what is sanitizing then?

…always **SECOND**

- Treatment of a ***cleaned surface***
- **Act on organic matter** – *hence why we clean*
- *(Typically)* **chemical** means of:
  - Ripping apart microbe's cells
  - Destroying their colonies
  - Killing bacteria and viruses
- May or *may not* have residual activity

Clean FIRST

Trucks, beds, pruning equip., floor surfaces

Overtime **surface can develop biofilms** →

- Can allow pathogens to survive from location to location
- Particularly root rot pathogens

- Clean floor mats regularly
- Physically clean flooring regularly
- Use sanitizers as appropriate for material
- Keep irrigation material off the floor

ALWAYS SANITIZE AFTER DISEASED MATERIALS

Pseudomonas aeruginosa

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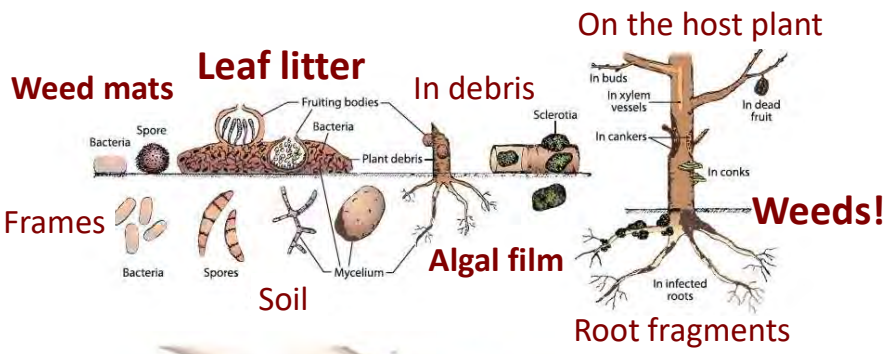
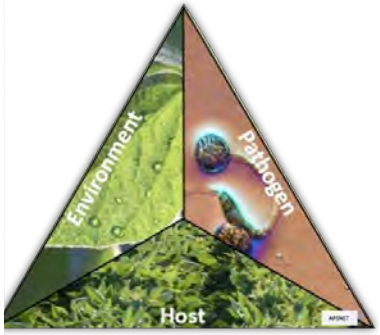
Boots & Clothing

Boots can spread SOOO MANY PROBLEMS





ALWAYS SANITIZE AFTER DISEASED MATERIALS!

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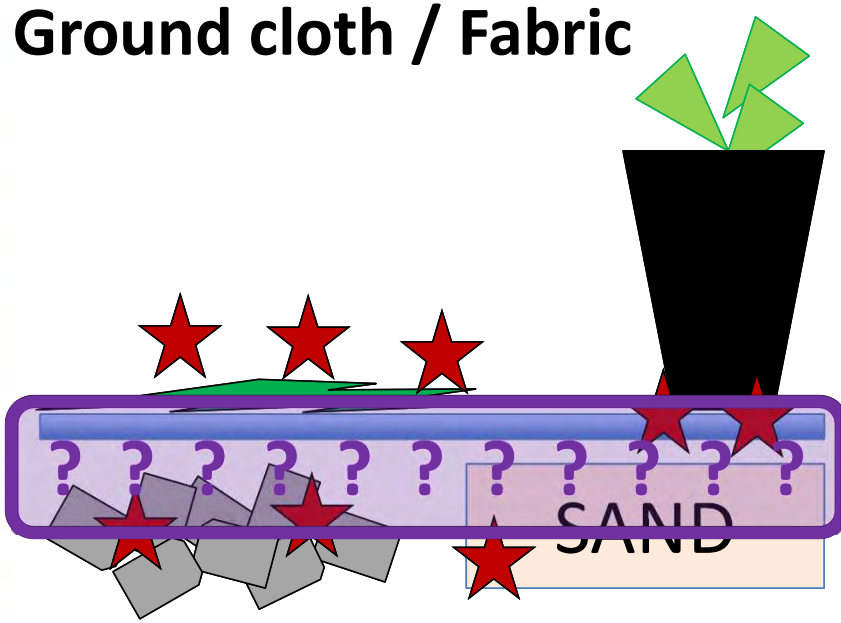
Practices matter – food for thought

Containers should not be set directly on soil where *Phytophthora* can be splashed up onto plants, causing foliar blight and root rot.

Ground cloth / Fabric



★ = Pathogen

https://ww
ons/nurser

Research - Pathogen survival in weed mats?

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Containers

- Discarding pots and flats after use is the most effective method to prevent pathogen spread from containers
- If Fusarium, Rhizoctonia, or Phytop/Pythium are problems, **ALWAYS use new containers**
- If reusing containers
  - Wash with soap and water, RINSE
  - Disinfest with product labeled for that purpose (OxiDate)

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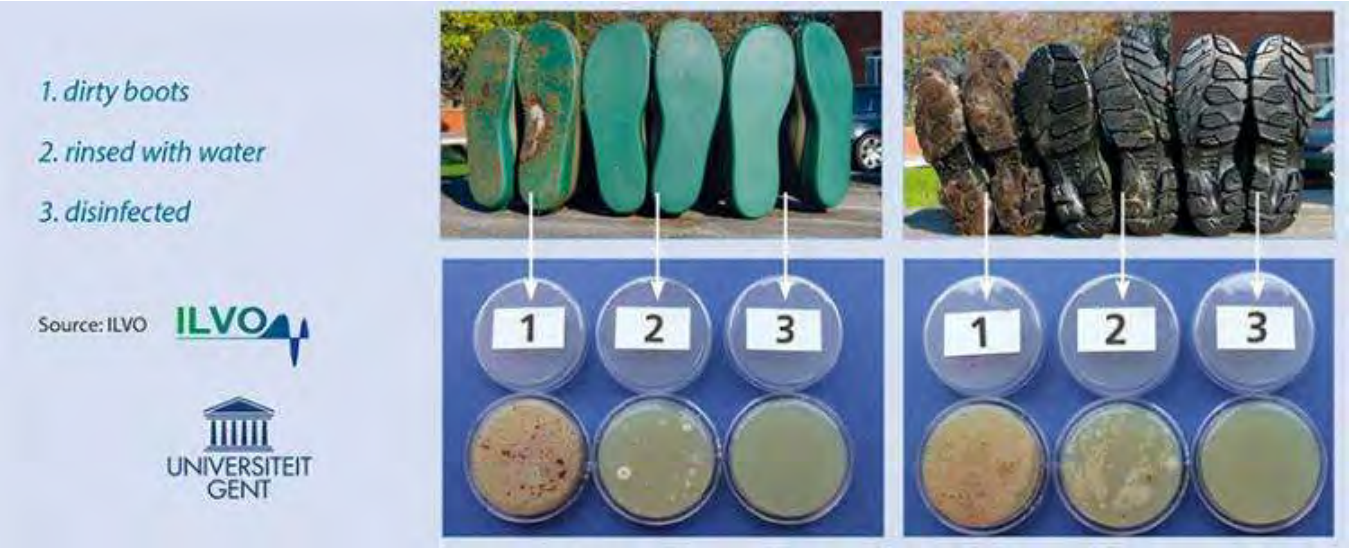
Footbaths

- Remove soil and debris from shoes before entering
- **Footbaths** with disinfectant in front of entrances
- Have brushes and hoses outside of greenhouse entrances
- Many products **labeled** for such



https://www.farmbiosecurity.com.au/biosecurity-basics-make-your-own-footbath/

Keep it fresh!

Photo: Washington State University

https://plantpathology.ca.uky.edu/files/ppfs-gh-07.pdf

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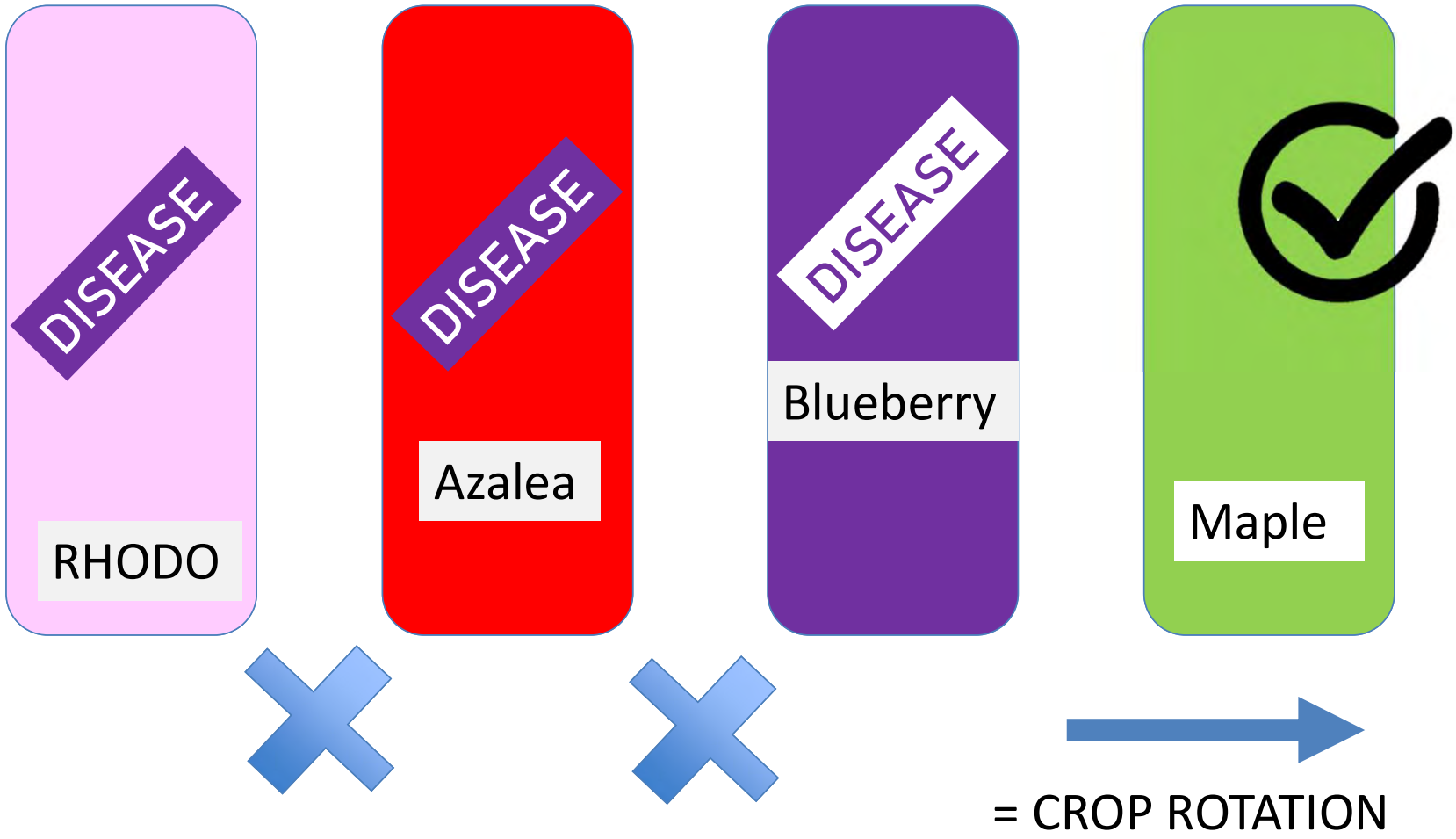
Host modifications



Amphimobile Systemic

Truly systemic – [PO7]

[Plant defense activator]

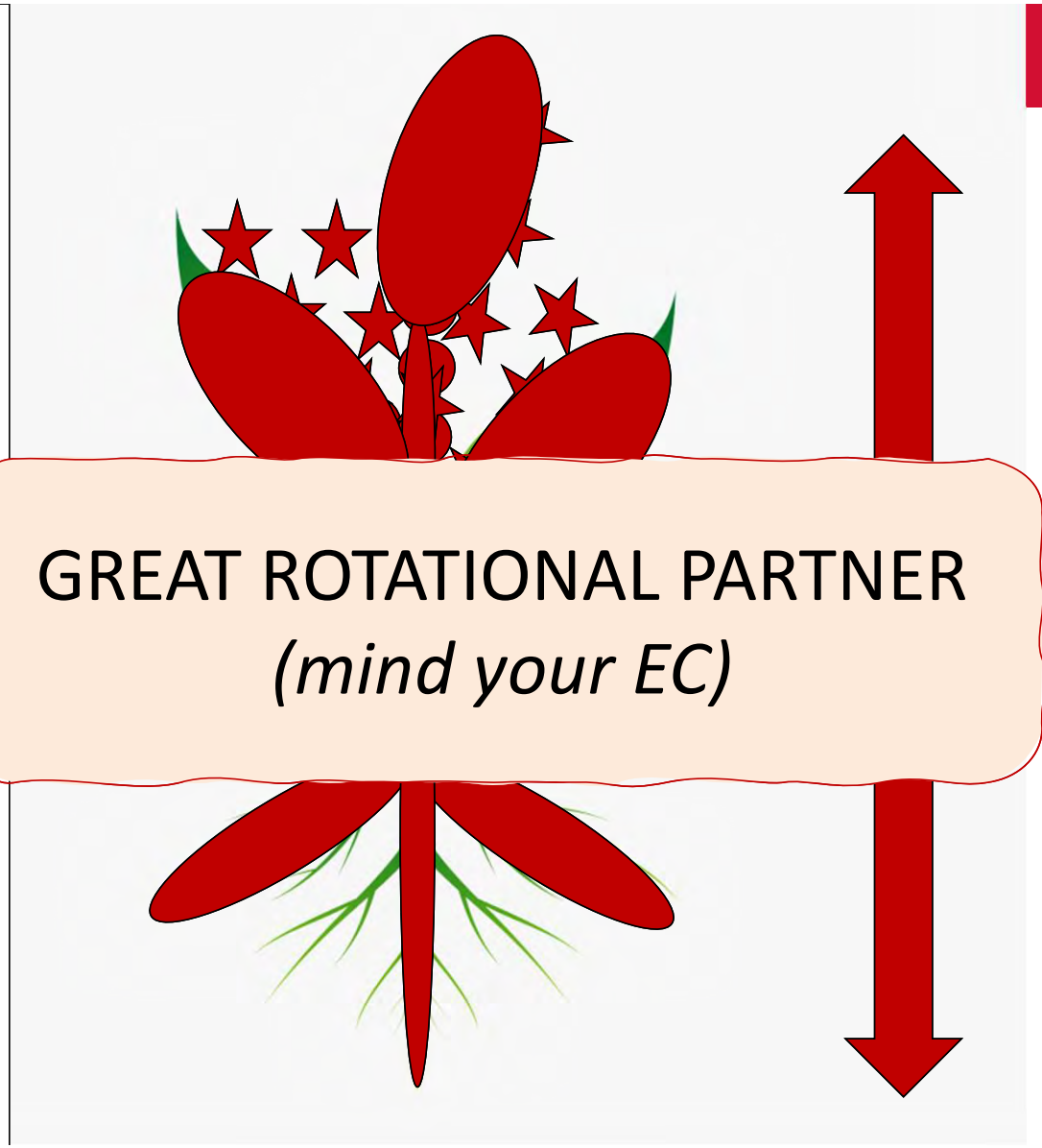
- **Xylem AND Phloem!!**
- Foliar and drench efficacy

Not perfect

- No copper within 14d
- Every 30d for most drench

Two phosphonate chemistries

- K salts of phosphorous acid
- Fosetyl-Al *(aluminum stabilized)*



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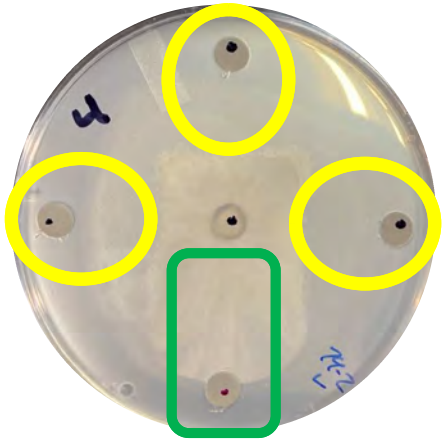
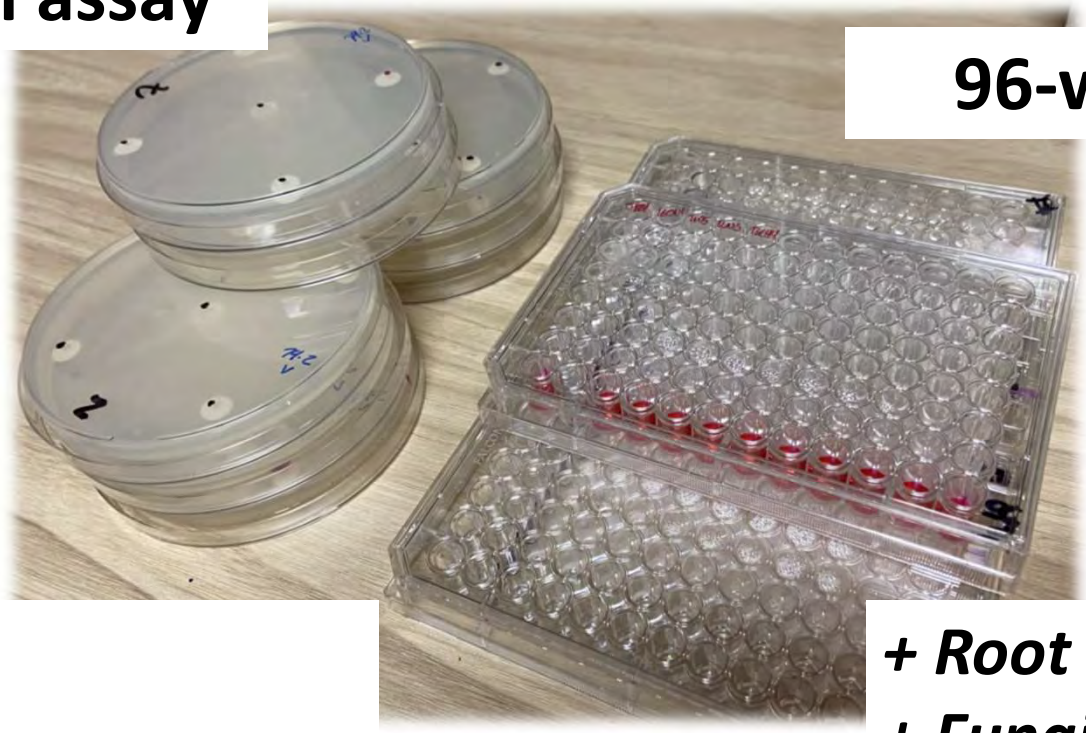
Bioassays – *inform future field trials*

Disk-diffusion assay



+ Fungicides

Direct toxicity of chems.



96-well bioassay

+ Root signals
+ Fungicides

<u>Pathogen survival</u>

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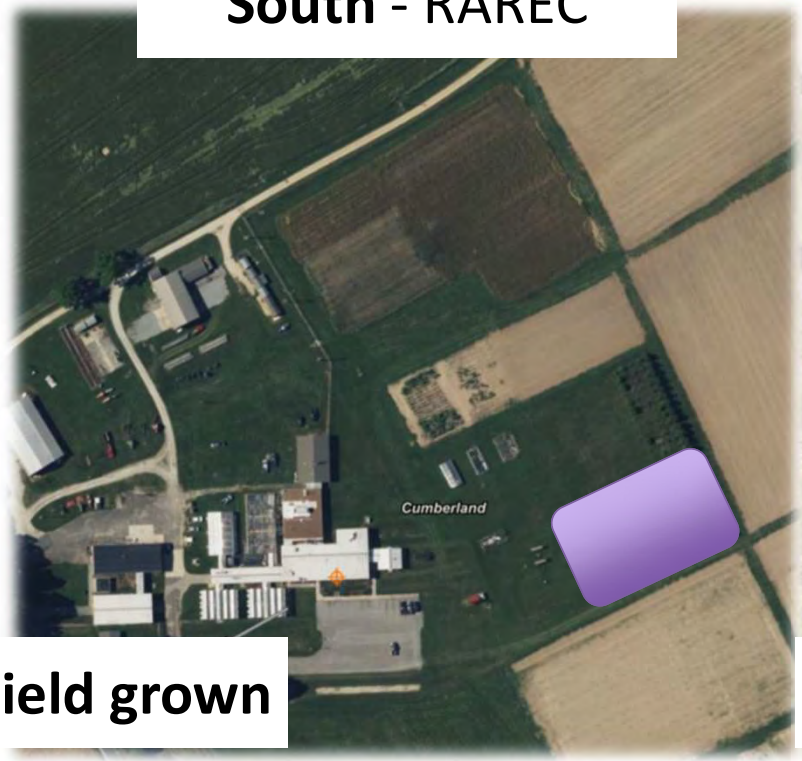
Rutgers Field Demonstration Areas

South - RAREC



Field grown

Tunnels

-Native Plants
-Christmas Trees
-Boxwood alternatives
-Pest Populations

Place for growers: new varieties, irrigation approaches fungicide / insecticide trials, planting techniques, **meetings**

#1 Management tool for Oomycetes

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RUTGERS UNIVERSITY
Cooperative Extension
New Jersey Agricultural Experiment Station

NJNLA
FOUNDED IN 1915 100 YEARS & GROWING
NEW JERSEY NURSERY & LANDSCAPE ASSOCIATION

New Jersey Landscape Contractors Association
NJLCA
Growing Every Day

New Jersey Conservation
FOUNDATION

Perennial Plant
ASSOCIATION

HOFFMAN
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THE NATIVE PLANT SOCIETY OF NEW JERSEY

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