



# Making Every Seed Count: Who's Responsible for Soybean Stand Loss?

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**Assistant Professor**  
**Field Crops Pathologist**

# What are we going to do today?

## Outline

- Seedling diseases and the pathogens that cause them
- Using seed treatments to protect stand

## Knowledge gain

- Improved knowledge of pathogens causing stand loss in corn and soybean
- Improved understanding of soybean treatments





# Many factors affect stand establishment

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- Compaction
- Flooding
- Crusting
- **Seedling diseases**
- Insect damage
- Cold stress
- Imbibitional chilling damage
- Residue coverage
- Sidewall compaction
- Dry soils
- Herbicide injury
- Poor seed quality
- Low germination
- Planting depth

# Symptoms of seedling disease

Gaps in planting row

Rotted seeds

Wilting seedlings

Root rot



Dept. Crop Sciences, U. Illinois





# CAREFUL!! There are imposters

Herbicide injury – PPO injury  
(saflefenacil, sulfentrazone, flumioxazin)



Stephanie Porter, Purdue Univ.

# What causes seedling diseases?

oomycetes

fungi



*Pythium*  
spp.



*Phytophthora*  
*sojae*



*Rhizoctonia*  
*solani*



*Fusarium*  
spp.



# Oomycete releasing zoospores



Rizzo lab at UC Davis <https://www.youtube.com/watch?v=hsdYrSgR4Ag>

# What causes seedling diseases?

oomycetes

Require free water for swimming spores



fungi

Don't need free water



Many states don't know who the players are



*Pythium*  
spp.



*Phytophthora*  
*sojae*



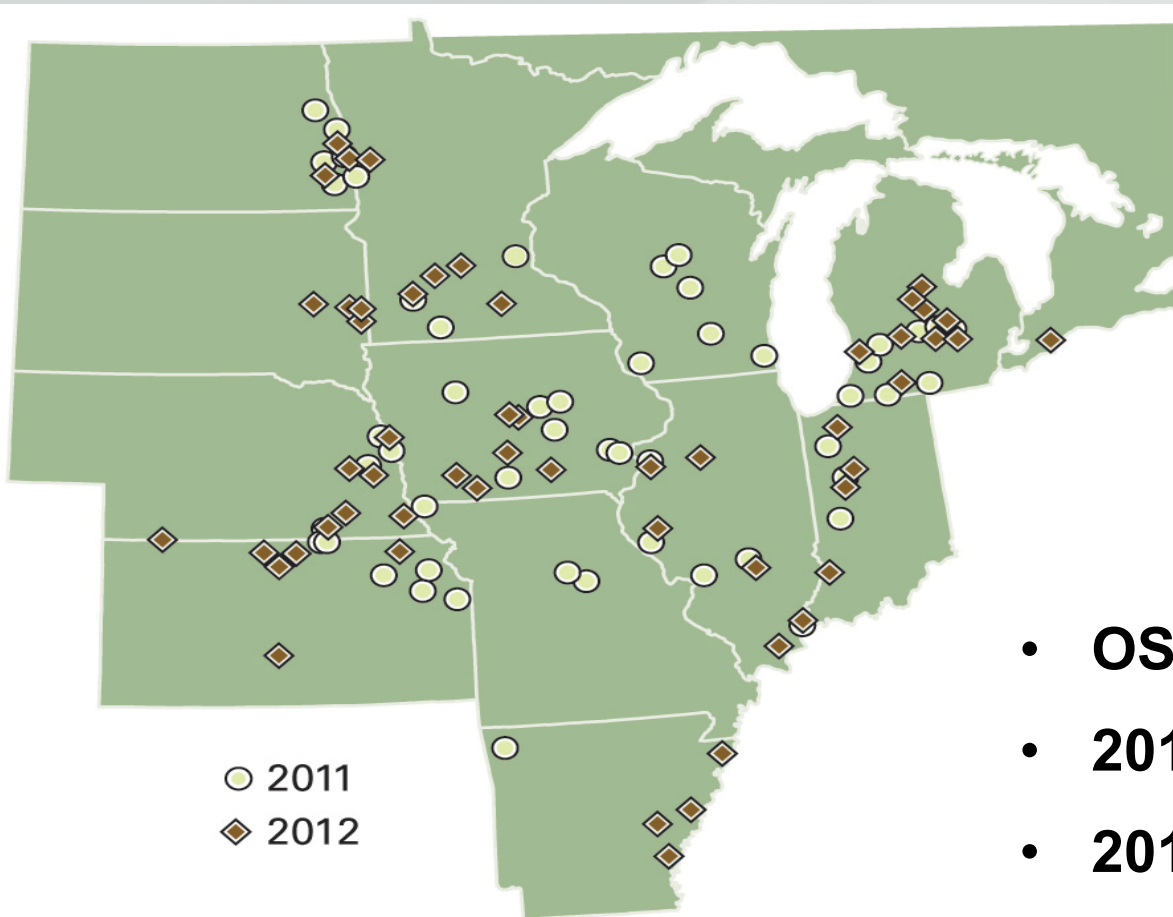
*Rhizoctonia*  
*solani*



*Fusarium*  
spp.



# Soybean seedling disease survey



- OSCAP Extension Network
- 2011-2012 (USDA-NIFA)
- 2012-2013 (USB & NCSRP)
- Targeted problem fields
  - 50 seedlings/field
  - 6 fields/state

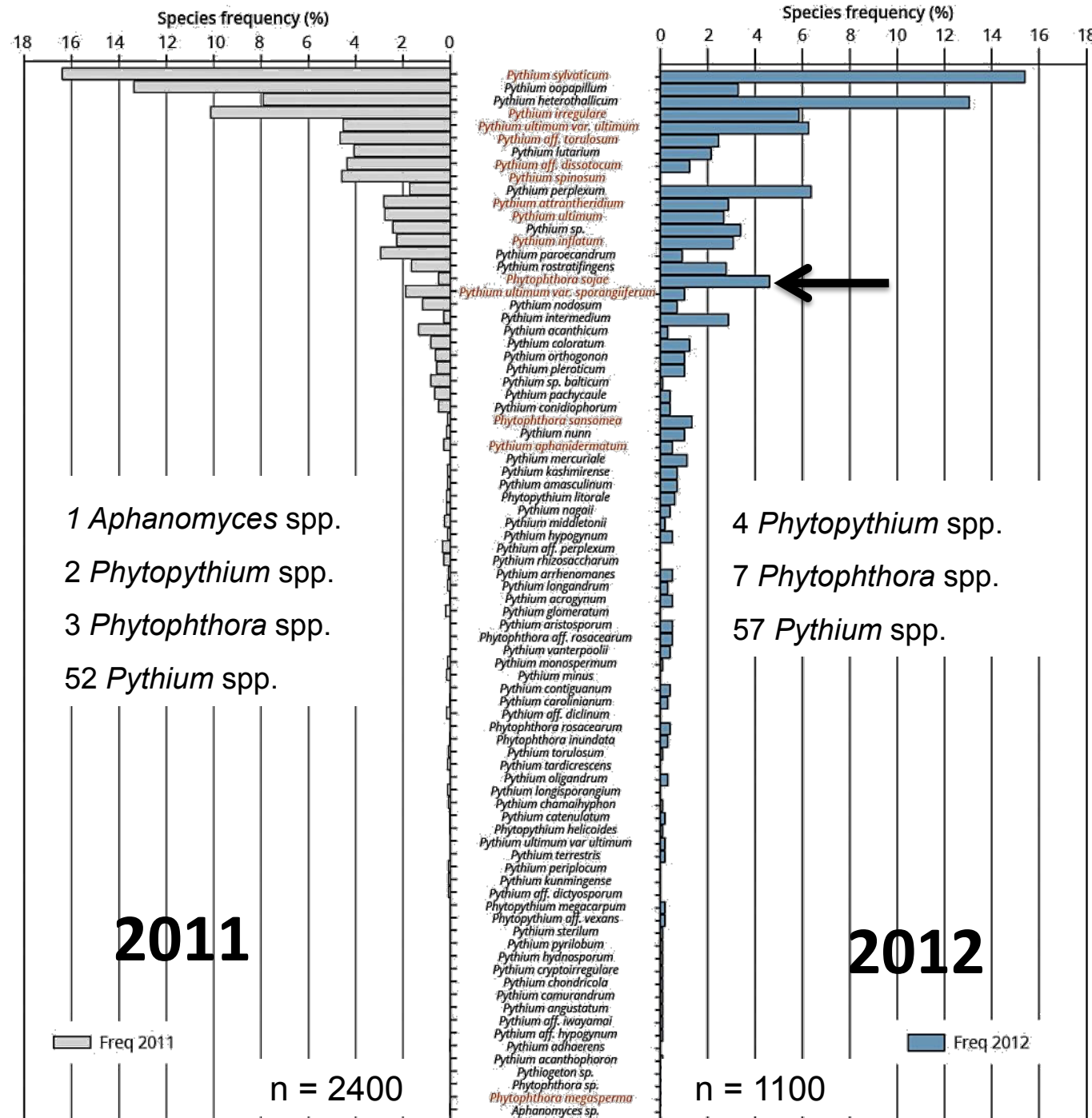
# Soybean seedling disease survey

- Isolation from diseased seedlings

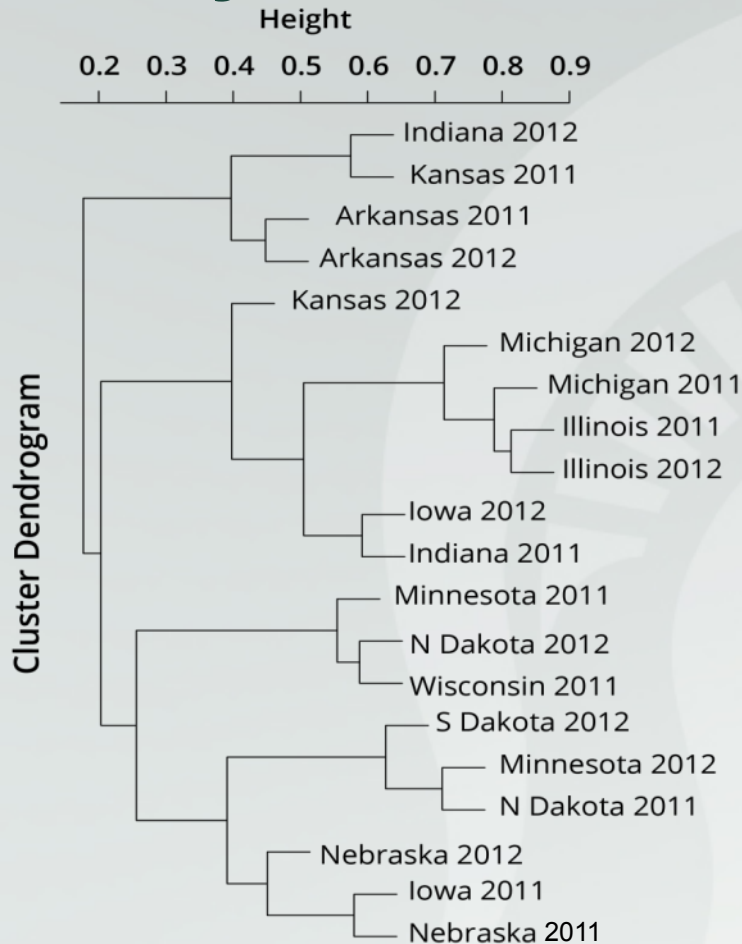




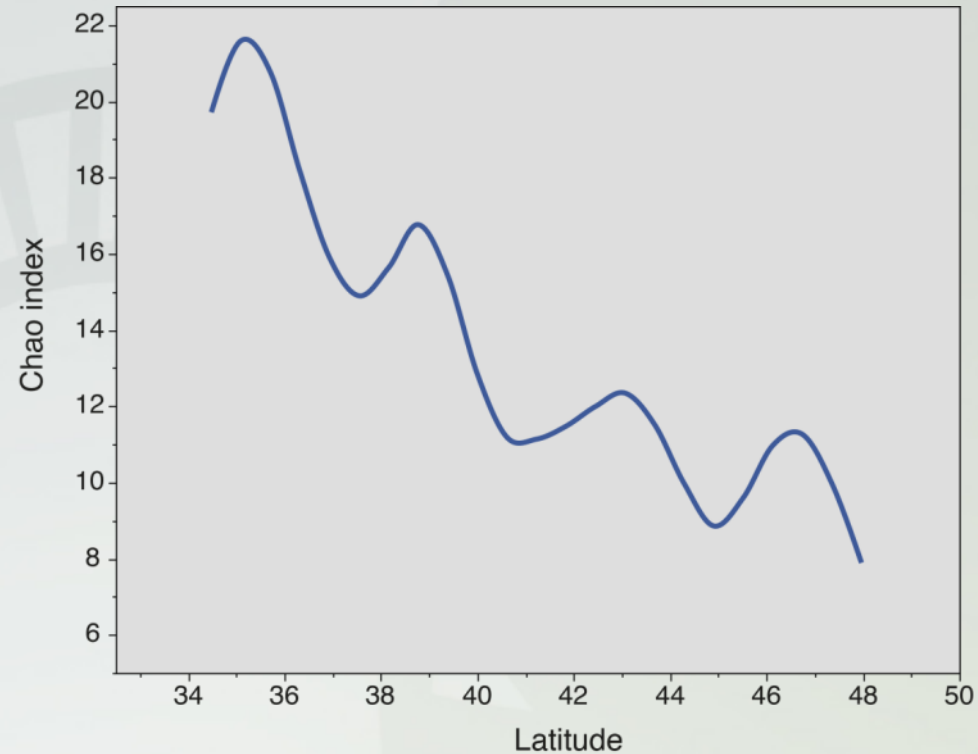
- 82 oomycete species
- Species frequency fluctuated between years
- 13 species reported as known pathogens



# Oomycetes community structure



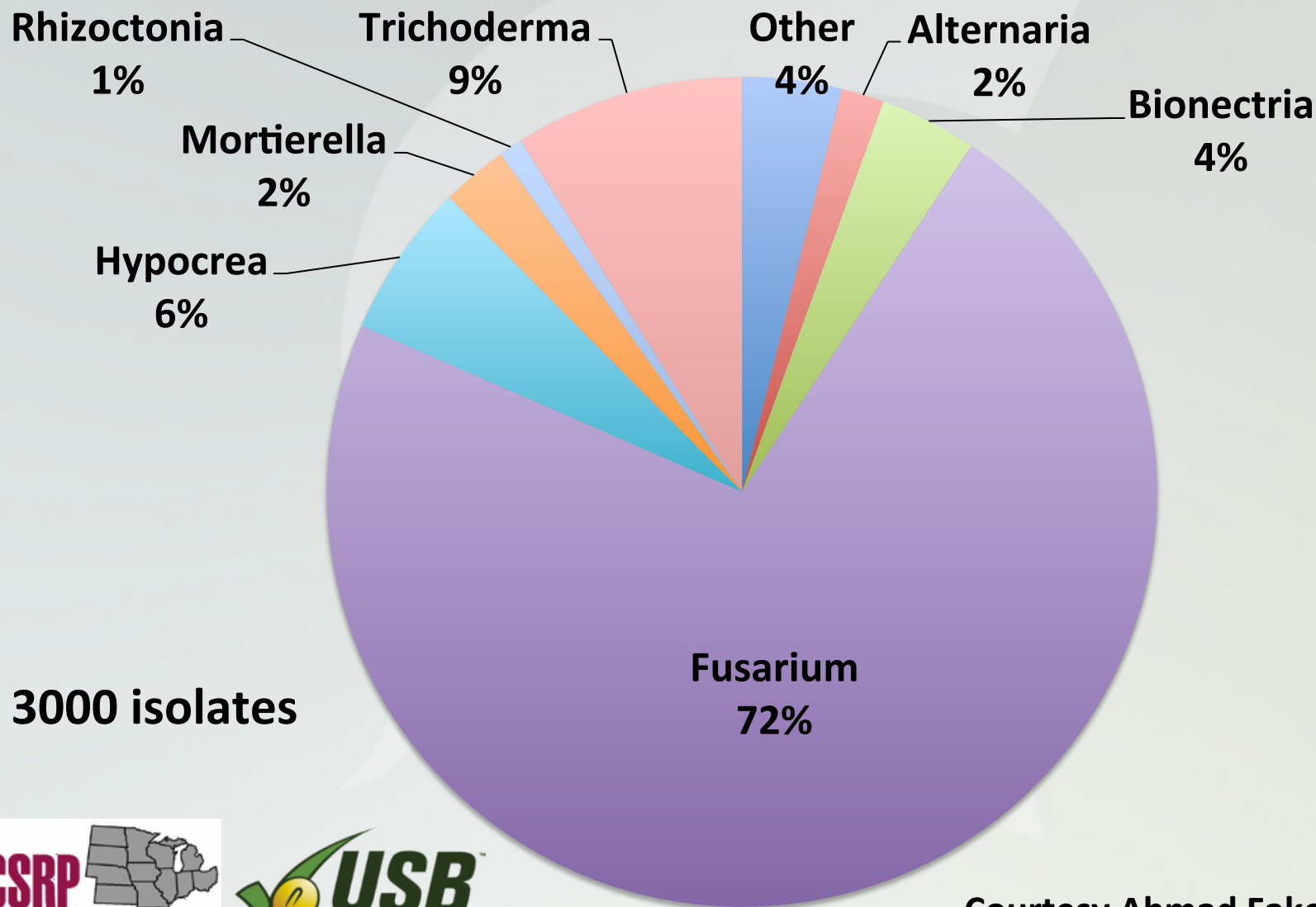
State ANOSIM R: 0.2343  
Significance: 0.001



Latitude ANOSIM R: 0.1679  
Significance: 0.001

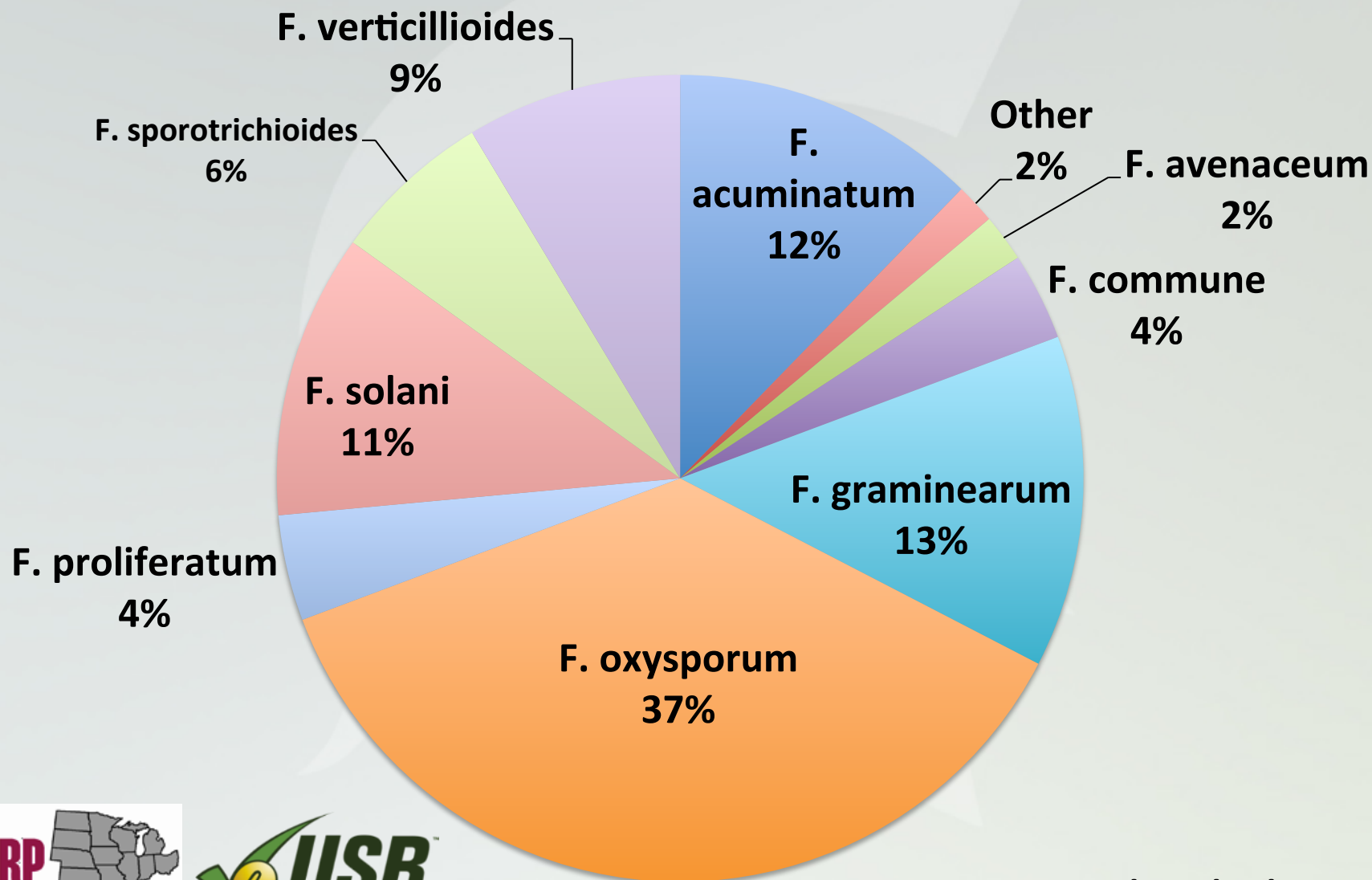
- States were clustered based on relative abundance of the species
- Latitude is correlated with species richness

# Fungi associated with diseased soybean seedlings

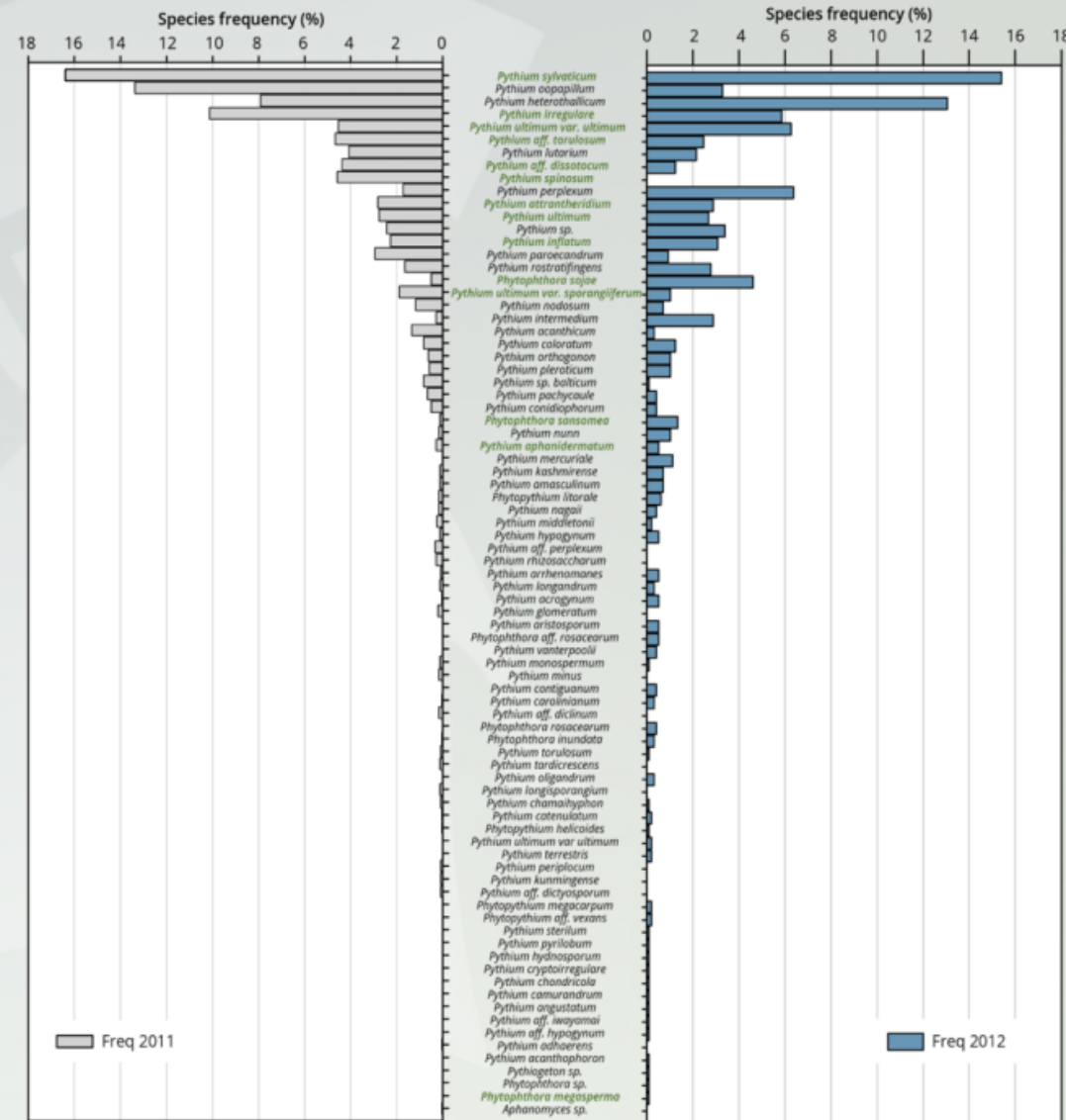




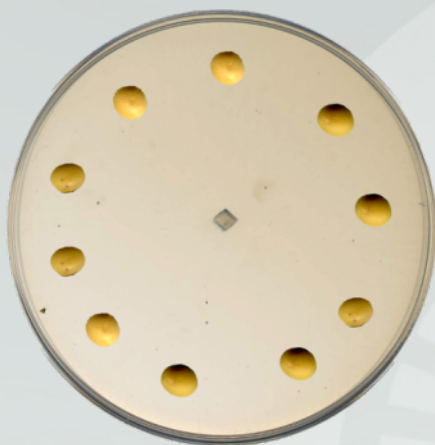
# *Fusarium* species



- Many beneficial microbial species in soil
- Which species cause disease?
- Does plant growth stage affect susceptibility?
- What effect does temperature have on disease?

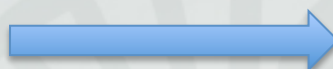


# Seed Rot Assays



Pathogen +  
Seed

7days in dark



55 and 68 F



**Disease Index = (DI)**

Severity

- |          |                                    |
|----------|------------------------------------|
| <b>0</b> | Germinated                         |
| <b>1</b> | Delayed germination                |
| <b>2</b> | Germination and some lesions       |
| <b>3</b> | Germination with coalesced lesions |
| <b>4</b> | Seed colonized                     |

$$DI = \frac{\sum(\text{severity} \times n)}{N}$$



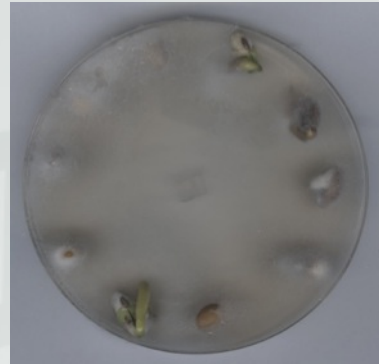
# Seed Rot Assays



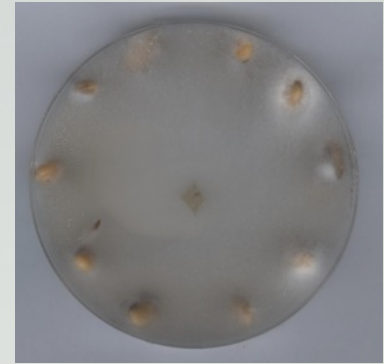
Control



*Pythium oopapillum*



*Pythium irregulare*



*Pythium ultimum* var.  
*ultimum*



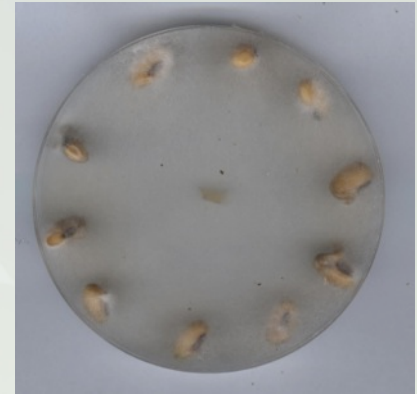
*Phytophthora sojae*



*Pythium sylvaticum*

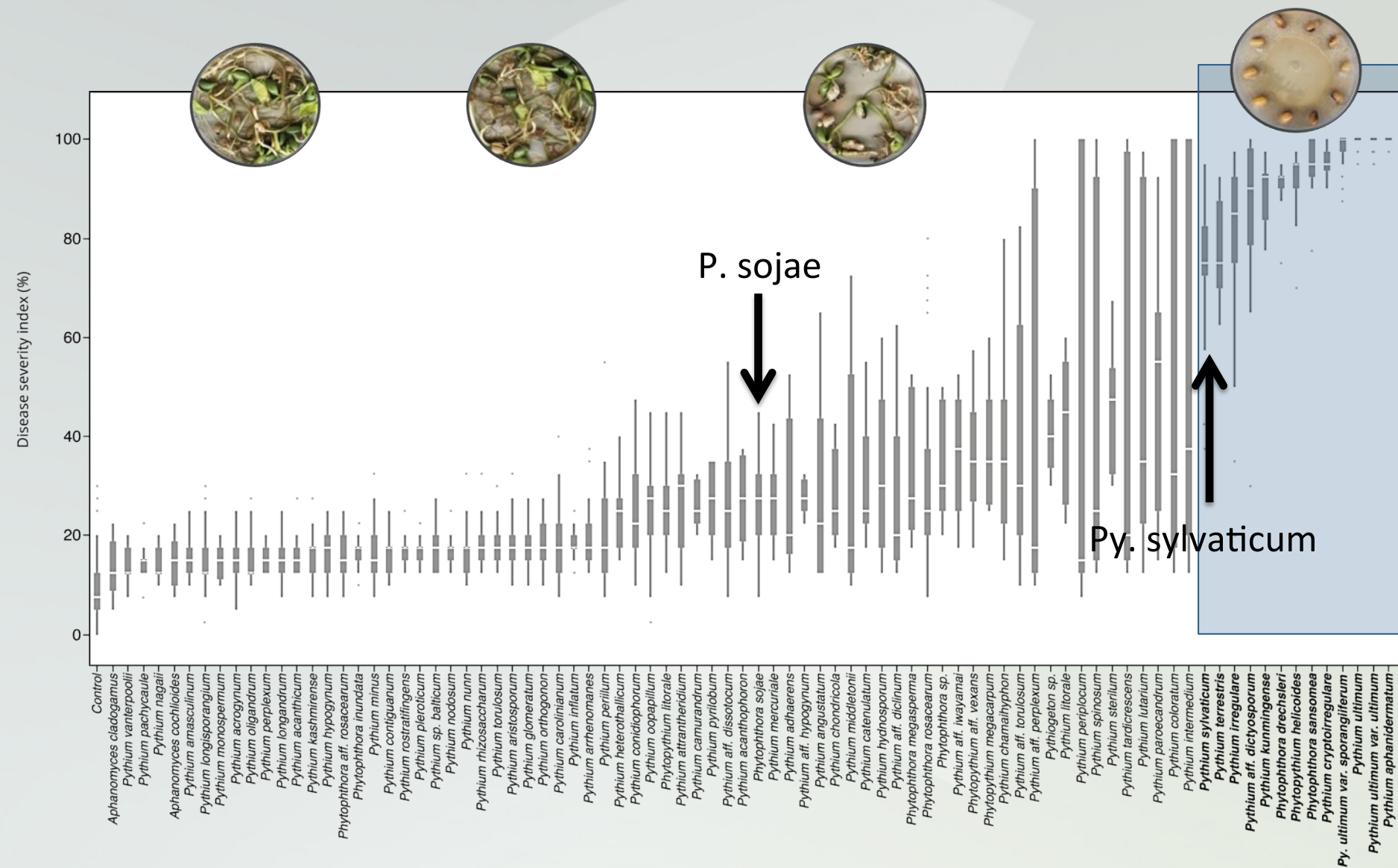


*Pythium attrantheridium*

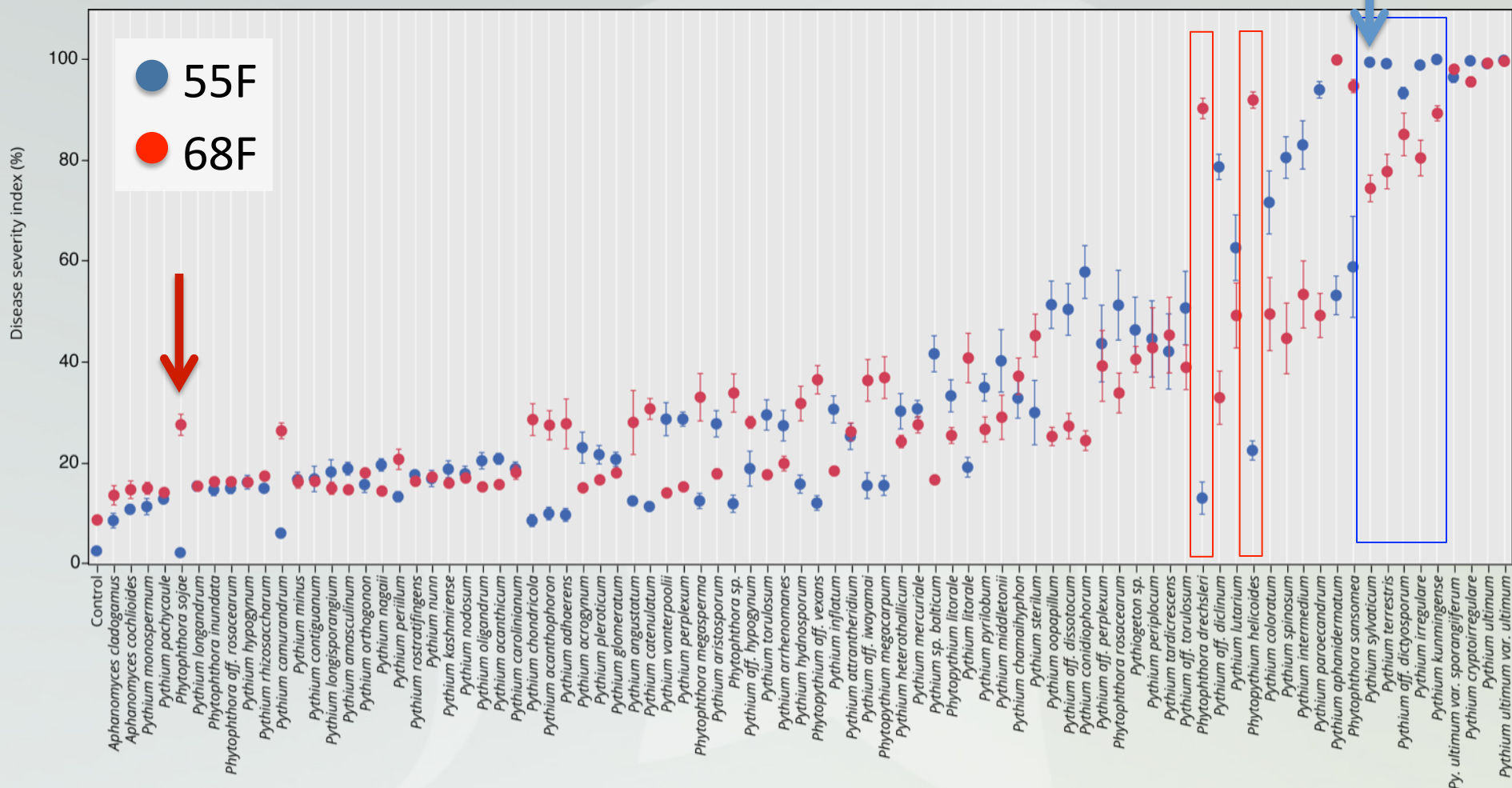


*Pythium ultimum* var.  
*sporangiiiferum*

# Seed rot severity index DI at 68°F



# Seed rot DI – 13°C (55°F) vs 20°C (68°F)



- *P. oopapillum* prevalent in cooler 2011 – more pathogenic at 55°F than 68°F
- *P. sojae* not very aggressive on seed, slightly more at warmer temp.



# Seedling root rot assays



- Dry weight of roots and shoots
- Roots area and root length



# Seedling root rot assays



Control



*Pythium oopapillum*



*Pythium irregulare*



*Pythium ultimum* var.  
*ultimum*



*Phytophthora sojae*



*Pythium sylvaticum*

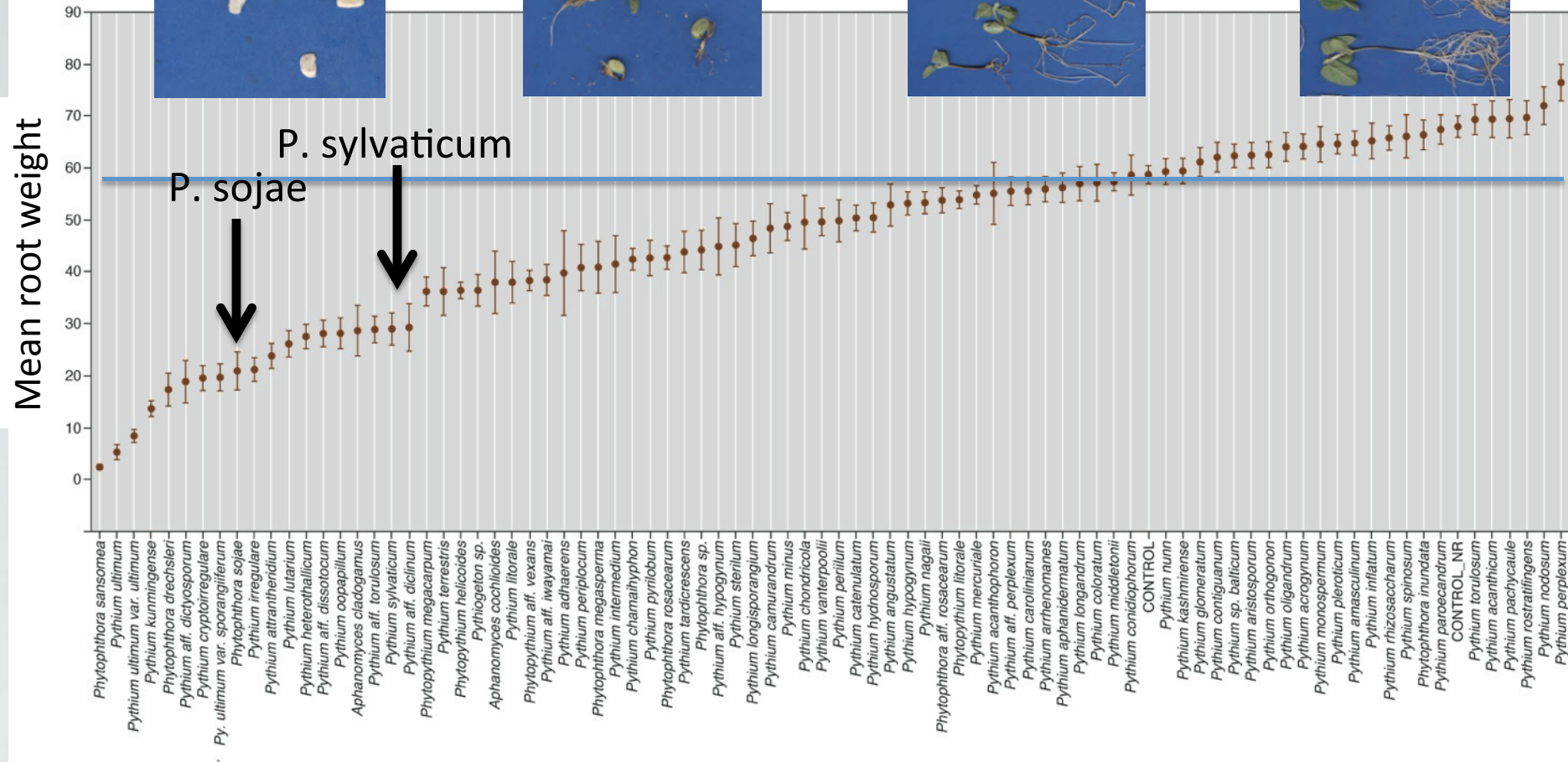


*Pythium attrantheridium*



*Pythium ultimum* var.  
*sporangiferum*

# Variability in seedling root rot at 68°F





# Seedling disease management

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- Plant when soil temperatures  $>55^{\circ}\text{F}$
- Ensure seedbed conditions are good
  - Soil moisture not excessive
- Plant seed at recommended planting depth
- Manage residue
- Seed applied fungicides



# Seed treatments for oomycetes

| Active ingredient       | Example of Product                                   | Chemical group          | FRAC group | <i>Phytophthora sojae</i> | <i>Pythium</i> species |
|-------------------------|------------------------------------------------------|-------------------------|------------|---------------------------|------------------------|
| mefenoxam/<br>metalaxyl | Apron <sup>®</sup> XL/<br>Allegiance <sup>®</sup> FL | Phenyl<br>amides        | <b>4</b>   | <b>E</b>                  | <b>E</b>               |
| ethaboxam               | Intego <sup>®</sup>                                  | Thiazole<br>carboximide | <b>U5</b>  | <b>E</b>                  | <b>E</b>               |
| azoxystrobin            | Dynasty <sup>®</sup>                                 | Qol<br>(Strobilurins)   | <b>11</b>  | -                         | <b>P</b>               |
| pyraclostrobin          | Stamina <sup>®</sup>                                 |                         |            | -                         | <b>P</b>               |
| trifloxystrobin         | Trilex <sup>®</sup><br>Flowable                      |                         |            | -                         | <b>P</b>               |

E = excellent; G = good; F = fair; P = poor; N = none

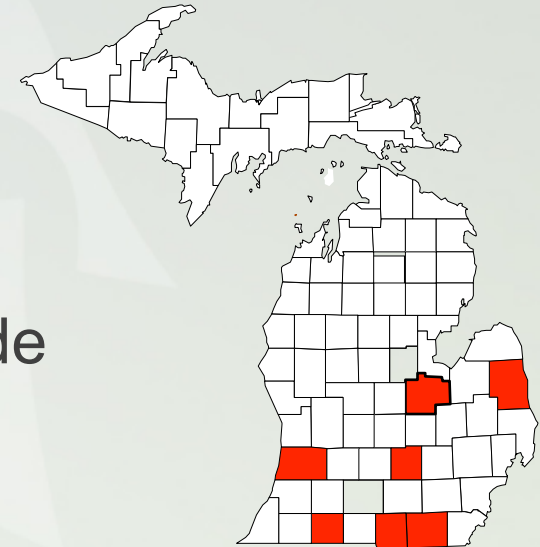
# Seed treatments for fungi

| Active ingredient | Example of Product              | Chemical group     | FRAC group | <i>Fusarium</i> species | <i>Rhizoctonia solani</i> |
|-------------------|---------------------------------|--------------------|------------|-------------------------|---------------------------|
| fludioxonil       | Maxim <sup>®</sup> 4FS          | PhenylPyrrols      | 12         | <b>G to E</b>           | <b>G</b>                  |
| sedaxane          | Vibrance <sup>®</sup>           | SDHI               | 7          | -                       | <b>E</b>                  |
| penflufen         | EverGoI <sup>™</sup> (PPST)     |                    |            |                         |                           |
| fluxapyroxad      | Xenium <sup>®</sup> (Acceleron) |                    |            |                         |                           |
| azoxystrobin      | Dynasty <sup>®</sup>            | QoI (Strobilurins) | 11         | <b>F</b>                | <b>F</b>                  |
| pyraclostrobin    | Stamina <sup>®</sup>            |                    |            |                         |                           |
| trifloxystrobin   | Trilex <sup>®</sup> Flowable    |                    |            |                         |                           |
| ipconazole        | Rancona <sup>®</sup>            | DMI (Triazole)     | 3          | <b>F</b>                | <b>G</b>                  |



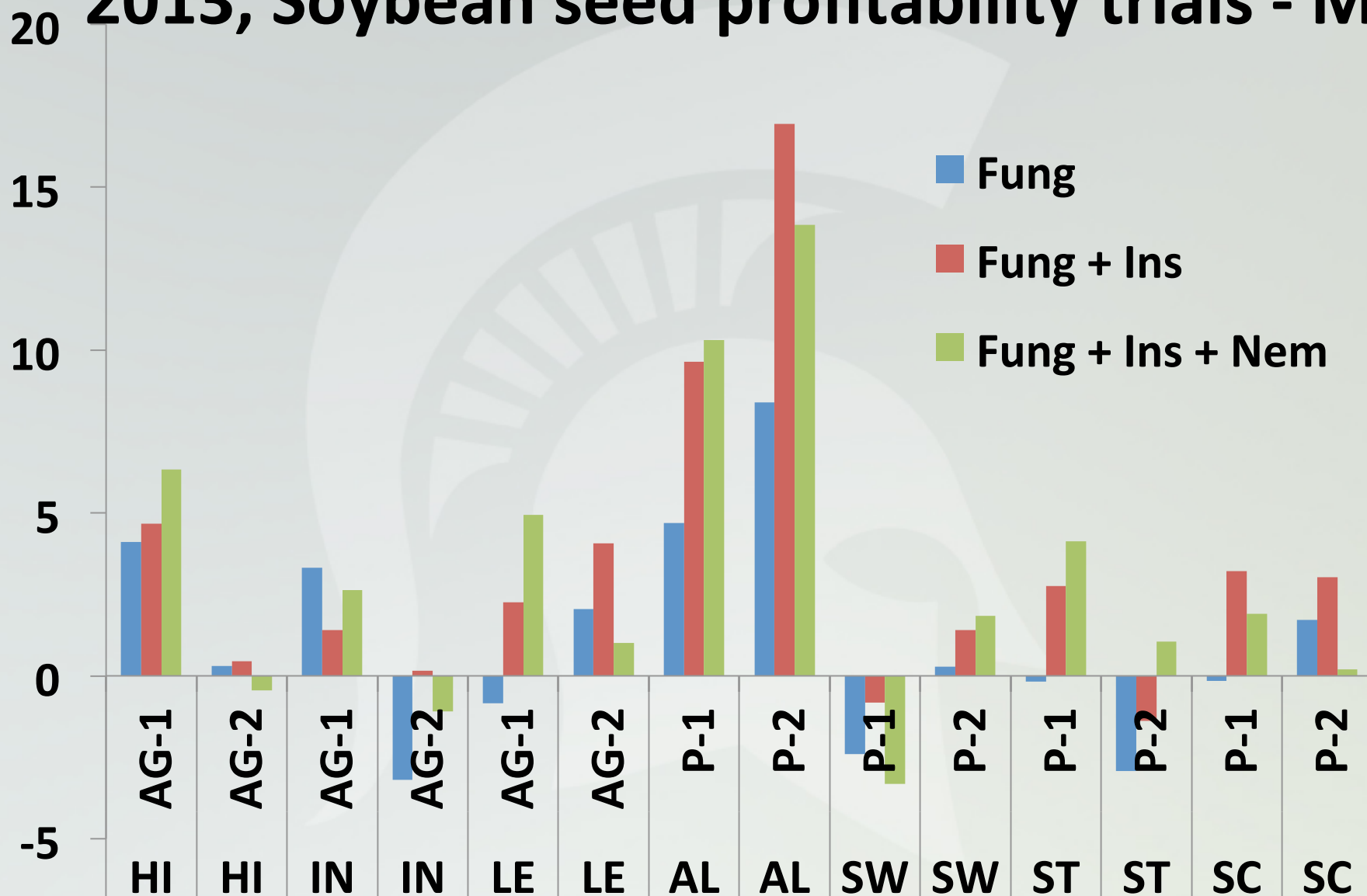
# 2013, Soybean seed profitability trials - MI

- Seven counties
  - Two Asgrow varieties (Hillsdale, Ingham, Lenawee)
  - Two Pioneer varieties (Allegan, St. Joseph, Saginaw, Sanilac)
- Four seed treatments
  - Untreated
  - Fungicide
  - Fungicide + Insecticide
  - Fungicide + Insecticide + Nematicide



# 2013, Soybean seed profitability trials - MI

Yield relative to untreated control (bu/A)



# Acknowledgements

Alejandro Rojas  
Janette Jacobs  
OSCAP Extension Network

Alison Robertson's lab  
Rashelle Matthiesen



Project No. 2011-68004-30104 ("Integrated management of oomycete diseases of soybean and other crop plants")



<http://passel.unl.edu/communities/oomycete>

# Want to know more?



Science-Based Agricultural Resources

Brought to you by  
The American Phytopathological Society  
American Society of Agronomy  
Crop Science Society of America

## Oomycete Diseases of Soybean and Current Management

<http://passel.unl.edu/communities/oomycete>

A screenshot of a web browser displaying the "Oomycete Learning Environment" website. The browser's address bar shows the URL "http://passel.unl.edu/communities/oomycete", which is circled in blue. A blue arrow points from this URL to the text above it. The website header includes the text "Plant &amp; Soil Sciences eLibrary &gt; Oomycete Learning Environment &gt; Home" and a "login" button. The main title is "Seedling diseases of corn Oomycete Learning Environment". Below the title is a search bar and a navigation menu with links for "Lessons", "Animations", "Glossary", "Discussion", and "Join Now". A "Get Started with CEUs" button is also visible in the bottom left corner. The main content area features four images: a close-up of green soybean leaves, a close-up of purple soybean flowers, a wide shot of a soybean field with irrigation equipment, and a close-up of a green soybean leaf.



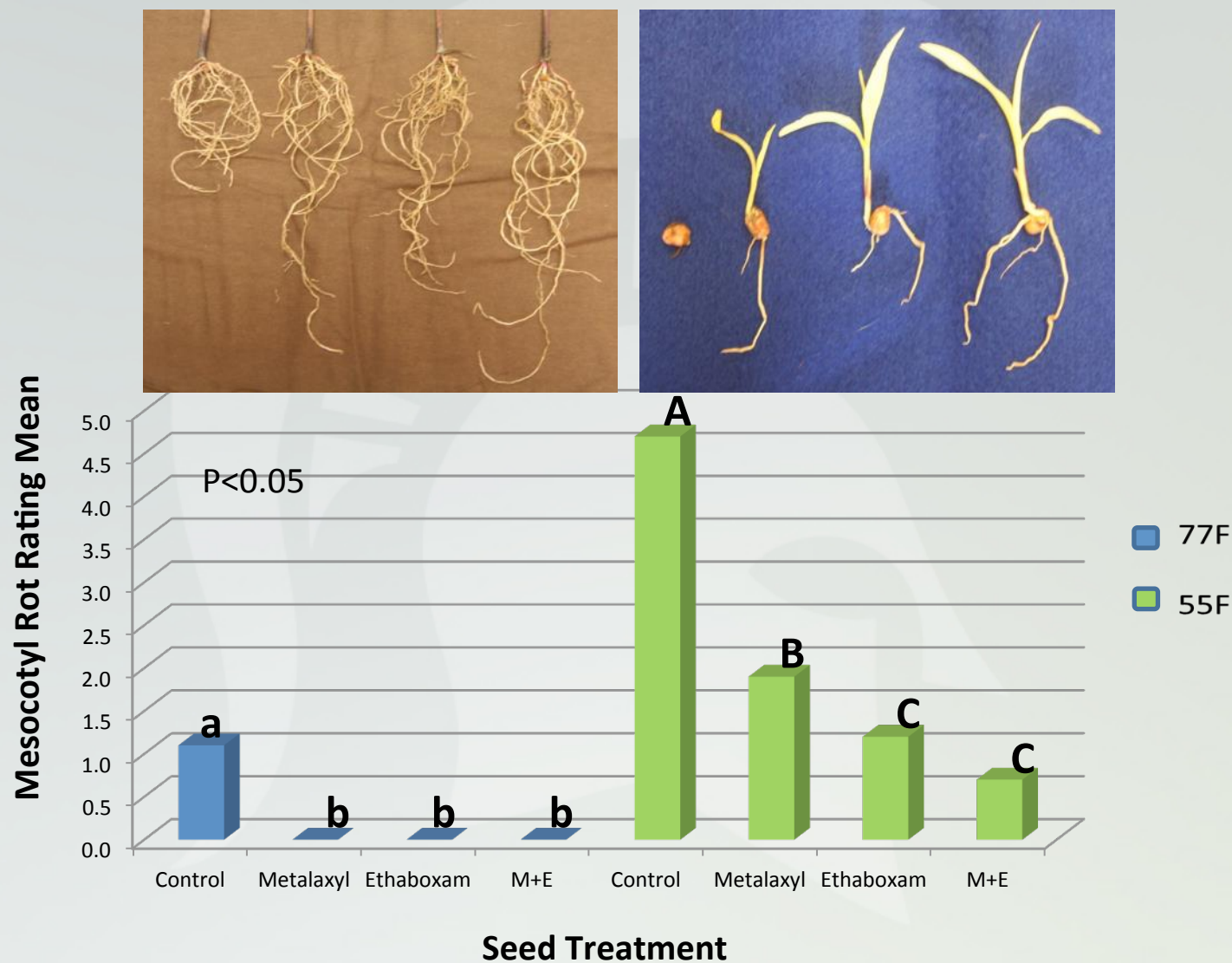
# Study Objectives

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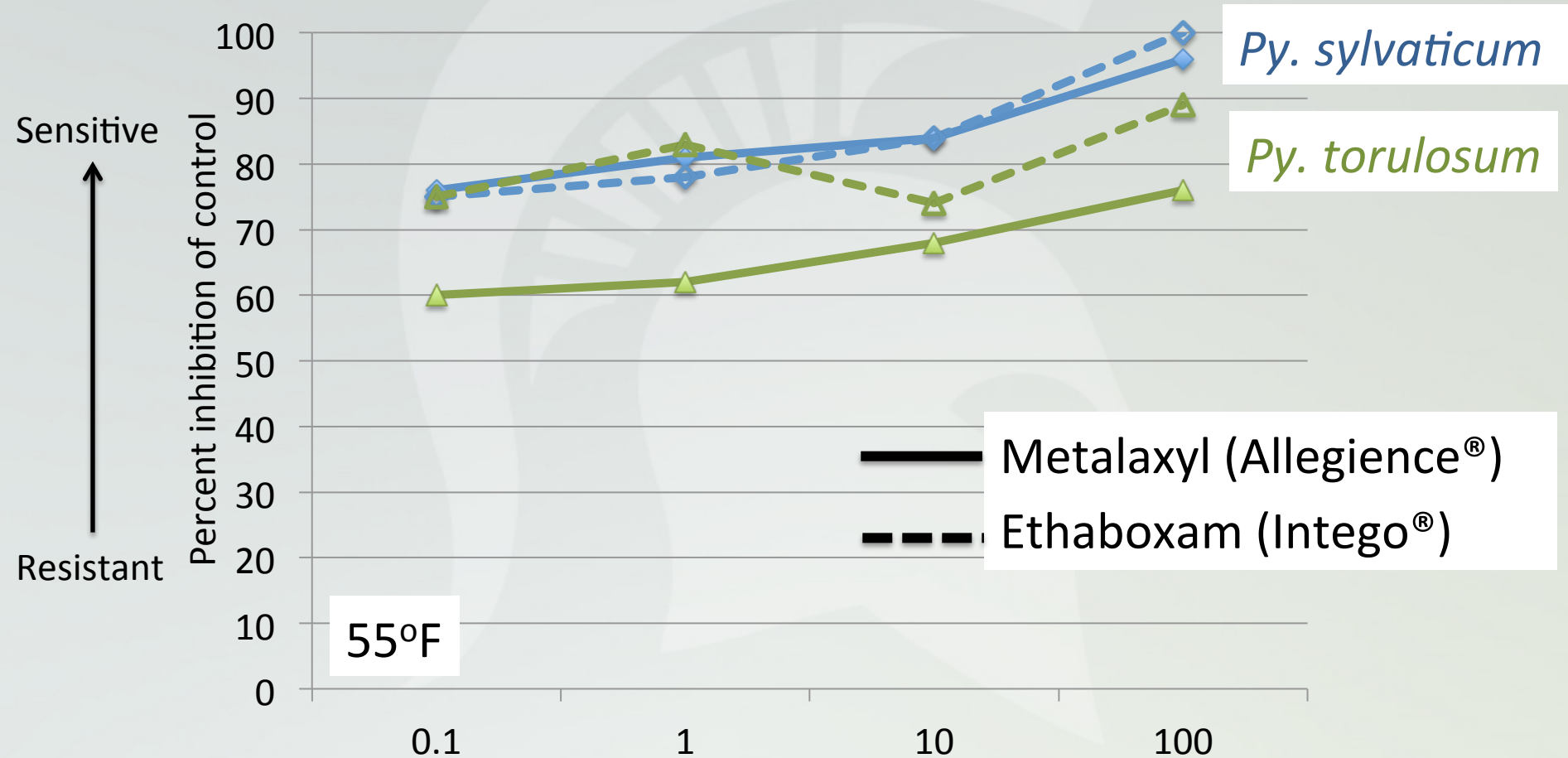
- Survey causal agents of soybean seedling disease
- Characterize pathogenicity and aggressiveness
- Determine fungicide sensitivity of pathogens
- Develop diagnostics for improved management



# Greenhouse evaluation of metalaxyl + ethaboxam on corn



# Sensitivity to fungicides varies amongst species and active ingredients



# Seed treatments

## What's on your seed?

Seed treatments have been used for a number of years, mostly for protection against seedling diseases. However, there are a number of new seed treatments marketed for protection against a range of pests—including seedling diseases, insects and nematodes—and even improving plant health.

The purpose of this publication is to take some of the confusion of seed treatments away, giving you a better understanding of what is on your seed. The list covers seed treatments registered in the state of Wisconsin for use on corn, soybean and/or small grain seed. The seed treatments are grouped by the number of active ingredients (1-4), treatment type (fungicide, insecticide, nematicide or plant growth regulator) and then alphabetically by the product trade name. The list is not based on efficacy of the seed treatments and is not an endorsement or criticism of one product over another. You are responsible for using pesticides according to the manufacturer's current label directions.

Authors: **Damon Smith**, Assistant Professor of Plant Pathology and  
**Richard Proost**, Nutrient and Pest Management Program



Treatment Type → **F** Fungicide **I** Insecticide **N** Nematicide **P** Plant Growth Regulator

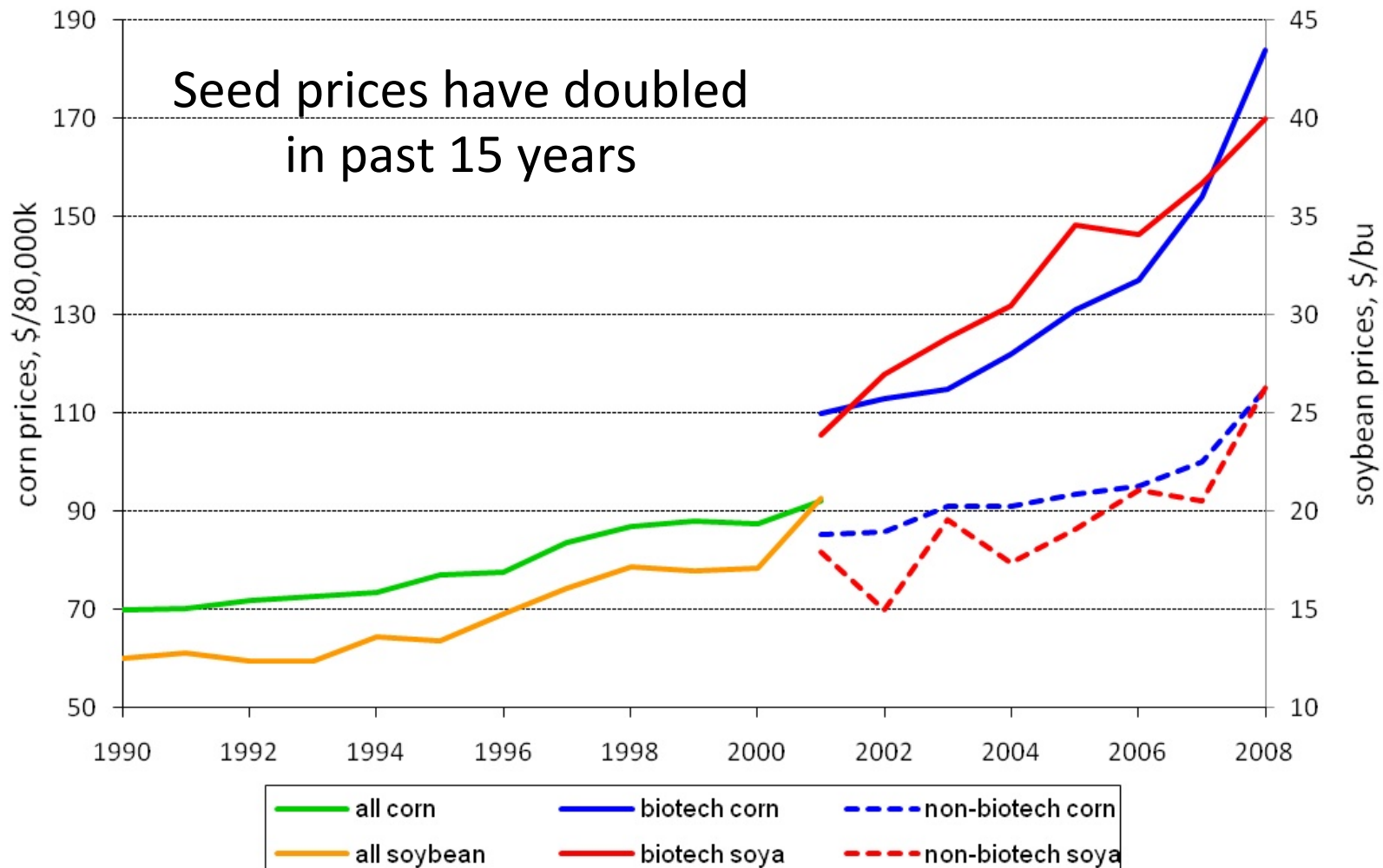
| Active Ingredient (s)             | Product Trade Name   | Crop                        |
|-----------------------------------|----------------------|-----------------------------|
| <b>F</b> azoxystrobin             | <b>Dynasty*</b>      | Corn, Soybean, Small Grains |
|                                   | <b>Protégé™ FL</b>   | Soybean                     |
| <b>F</b> <i>Bacillus pumilus</i>  | <b>Yield Shield*</b> | Corn, Soybean, Small Grains |
| <b>F</b> <i>Bacillus subtilis</i> | <b>HIStick® N/T</b>  | Soybean                     |
|                                   | <b>Kodiak® HB</b>    | Corn, Soybean, Small Grains |
|                                   | <b>Serenade® A50</b> | Corn, Soybean, Small Grains |
|                                   | <b>Subtlex® NG</b>   | Corn, Soybean, Small Grains |

|                                             |                                               |                             |
|---------------------------------------------|-----------------------------------------------|-----------------------------|
| <b>F</b> metconazole                        | <b>Metlock*</b>                               | Corn, Small Grains          |
| <b>F</b> pyraclostrobin                     | <b>Acceleron® DX-109</b>                      | Corn, Soybean, Small Grains |
|                                             | <b>Cabrio™ EG</b>                             | Corn, Soybean               |
|                                             | <b>Diamir</b>                                 | Corn, Soybean, Small Grains |
|                                             | <b>Stamina*</b>                               | Corn, Small Grains          |
| <b>F</b> Quinod saponins                    | <b>Heads Up® Seed Treatment</b>               | Corn, Soybean, Small Grains |
| <b>F</b> <i>Streptomyces lydicus</i>        | <b>Actinogrow™ ST</b>                         | Corn, Soybean, Small Grains |
|                                             | <b>Actinovate® AG</b>                         | Corn, Soybean, Small Grains |
| <b>F</b> tebuconazole                       | <b>Agri Star Tebustar 250 ST</b>              | Corn, Small Grains          |
|                                             | <b>AmTide Tebu 3.6F</b>                       | Corn                        |
|                                             | <b>Armortech® Teb 360</b>                     | Corn                        |
|                                             | <b>Raxil 2.6F</b>                             | Corn, Small Grains          |
|                                             | <b>Sativa® 309 FS</b>                         | Corn, Small Grains          |
|                                             | <b>Shizzle</b>                                | Corn                        |
|                                             | <b>Tebucon 3.55C</b>                          | Corn                        |
|                                             | <b>Tebucon 3.6F</b>                           | Corn                        |
|                                             | <b>Tebusha 3.6F</b>                           | Corn                        |
|                                             | <b>Tebuzol™ 3.6F</b>                          | Corn                        |
|                                             | <b>Tebuconazole 3.6</b>                       | Corn                        |
|                                             | <b>Toledo 3.6F</b>                            | Corn                        |
| <b>F</b> thiabendazole                      | <b>Mertect® 340-F</b>                         | Soybean                     |
| <b>F</b> thiram                             | <b>42-S Thiram</b>                            | Corn, Soybean, Small Grains |
|                                             | <b>Flowsan*</b>                               | Corn, Soybean, Small Grains |
|                                             | <b>Signet™ 480 FS</b>                         | Corn, Soybean, Small Grains |
| <b>F</b> <i>Trichoderma harzianum</i> Rifai | <b>Rootshield*</b>                            | Corn, Soybean, Small Grains |
| <b>F</b> trifloxystrobin                    | <b>Acceleron® DX-709</b>                      | Corn, Soybean, Small Grains |
|                                             | <b>Flint*</b>                                 | Corn, Small Grains          |
|                                             | <b>Trilex® Flowable</b>                       | Corn, Soybean, Small Grains |
| <b>F</b> triticonazole                      | <b>Charter*</b>                               | Small Grains                |
| <b>I</b> rhizoctonia                        | <b>Larshan® ENW</b> in water soluble solution | Corn                        |

- Fungicide
- Insecticide
- Nematicide
- Plant Growth regulator



# Goal: every seed planted = a productive plant



# Oomycetes

*Phytophthora sojae*,  
*Pythium* species

- Cell wall composed of cellulose
- No cross walls in hyphae
- “Swimming” spores



# True fungi

*Fusarium* species,  
*Rhizoctonia solani*

- Cell wall composed of chitin
- Cross walls in hyphae
- Air- or splashed-

