

Sustainable Soil- Borne Disease Management

Research at Kentucky
State University



Kentucky State University Organic Agriculture Working Group



Brings together researchers, teachers, and extension agents whose work relates to organic agriculture.



Types of Soil-Borne Diseases



Phytophthora



Fusarium

Aspergillus



Sclerotinia



Soil-Borne Diseases

Susceptible Host

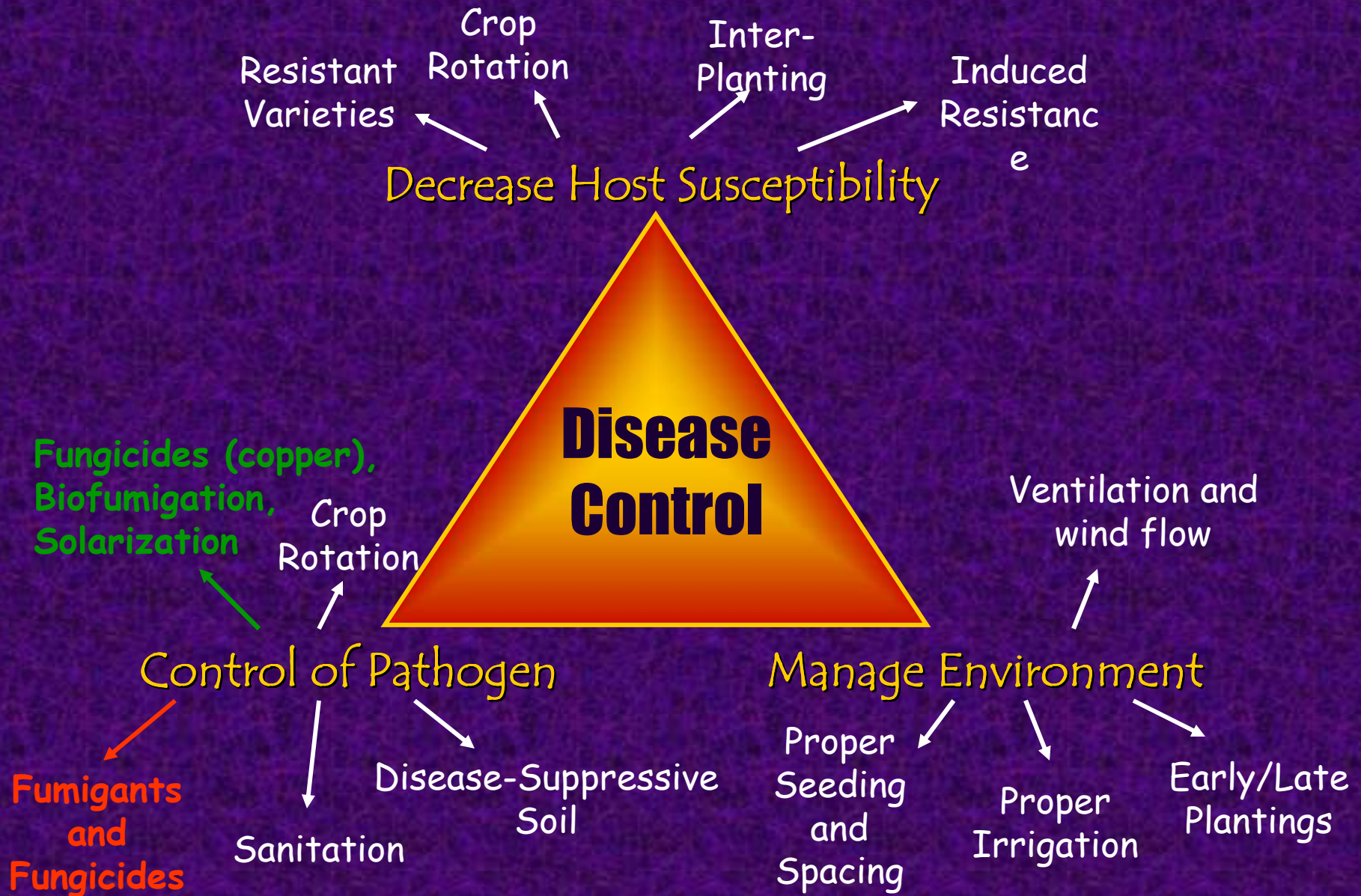


**Disease
Outbreak!**

Disease-causing Pathogen

Favorable Environment

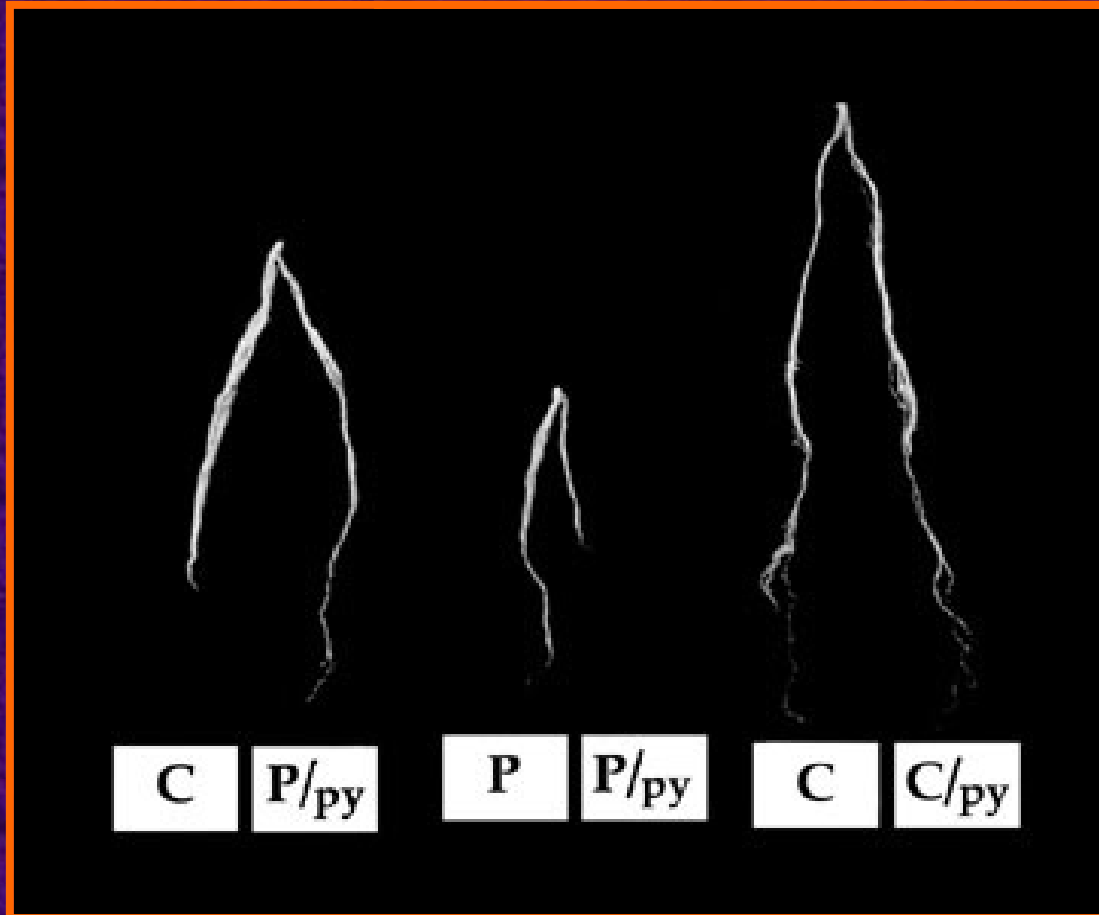
Soil-borne Disease Management



Soil-borne Disease Management

Decrease Host Susceptibility

"Induced Resistance"

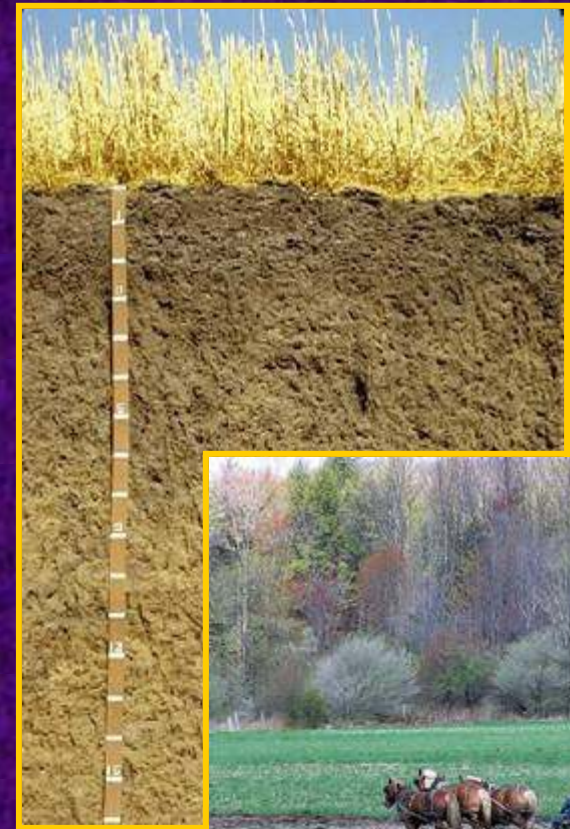




“Soil-Borne Diseases Result from a reduction of biodiversity of soil organisms.”



- 600-800 million individual bacteria of 10,000 species
- Miles of fungi of 5,000 species
- 20-30 nematodes of 100 species
- 10,000 individual protozoa of 100 species



Source: www.attra.org

Publication: “Sustainable Management of Soil-Borne Diseases”

Soil-borne Disease Management

Control of Pathogen

"Disease-Suppressive Soil"

A Disease-Suppressive Soil has:

- A biodiversity of soil microbes
- Large populations of active microbes ("active carbon")
- Good drainage and texture
- Pathogens cannot become established
- Pathogens get established but produce no disease
- Disease is produced for a short time and then declines



Direct
Parasitism

Competition

Induced
Resistance

Direct
Inhibition by
Secretions



"Wow, SOUNDS
great...but what
about REALITY?"



Research at Kentucky State University

- Evaluation of control strategies for *S. sclerotiorum*.
 - Soil Solarization and Biofumigation
- Strategies suitable for high tunnel systems in Kentucky.
- Follow National Organic Program guidelines.



Sclerotinia sclerotiorum “White Mold”



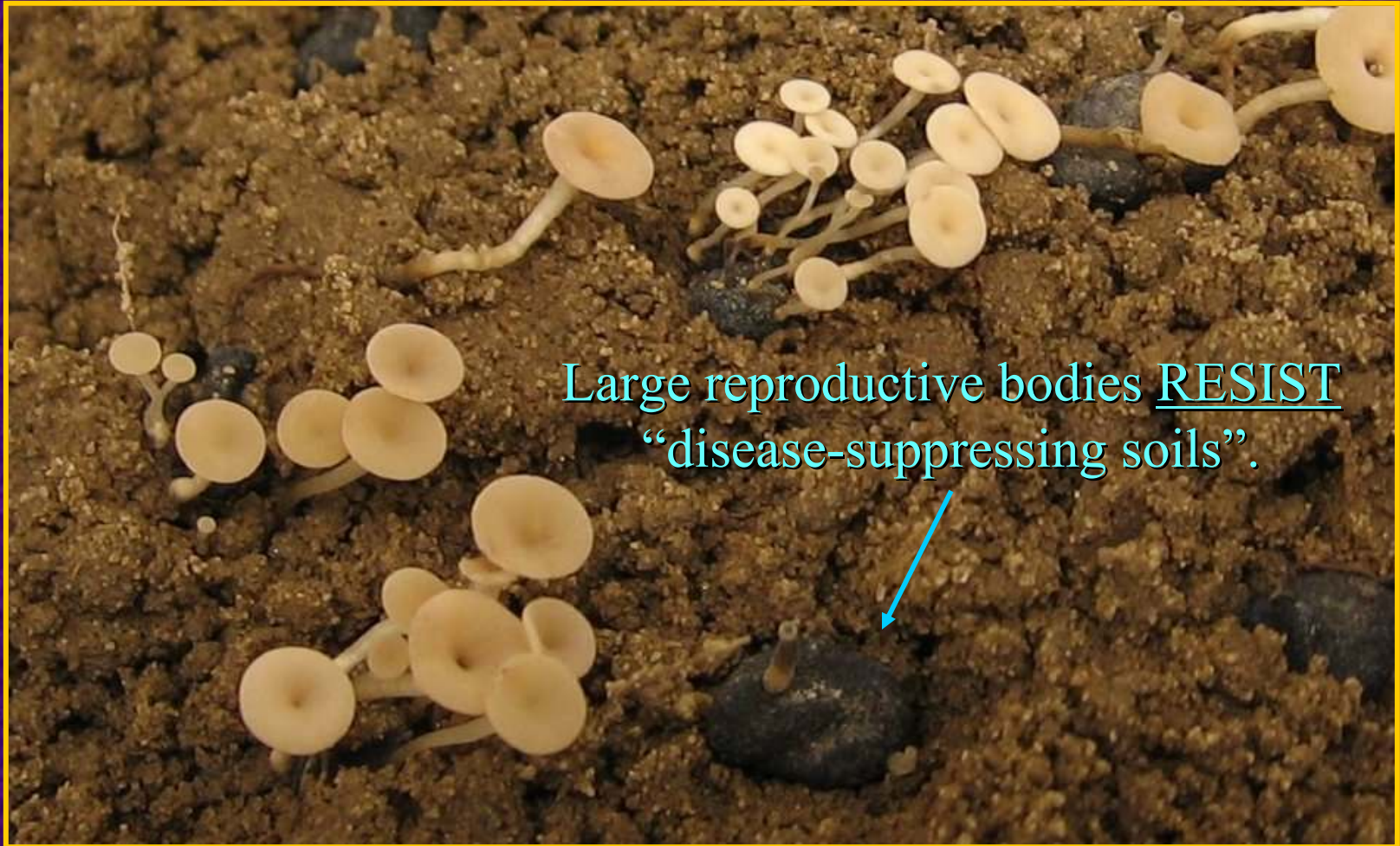
Sclerotinia sclerotiorum “White Mold”



Sclerotinia sclerotiorum “White Mold”



Sclerotinia sclerotiorum “White Mold”



Large reproductive bodies RESIST
“disease-suppressing soils”.

Sclerotinia sclerotiorum “White Mold”



SOIL SOLARIZATION



Clear plastic is used to raise soil temperatures and kill pests and/or weeds.



SOIL SOLARIZATION

Things to consider:

- Day length.
- Tillage/Soil preparation.
- Soil structure: large clumps can create pockets that do not heat up.
- Soil moisture: wet soil conducts heat quickly and uniformly.
- Soil moisture: dry seeds resist heat better than wet seeds.
- Sanitation: remember field edges and pathways.
- What about my beneficial soil microbes?

SOIL SOLARIZATION

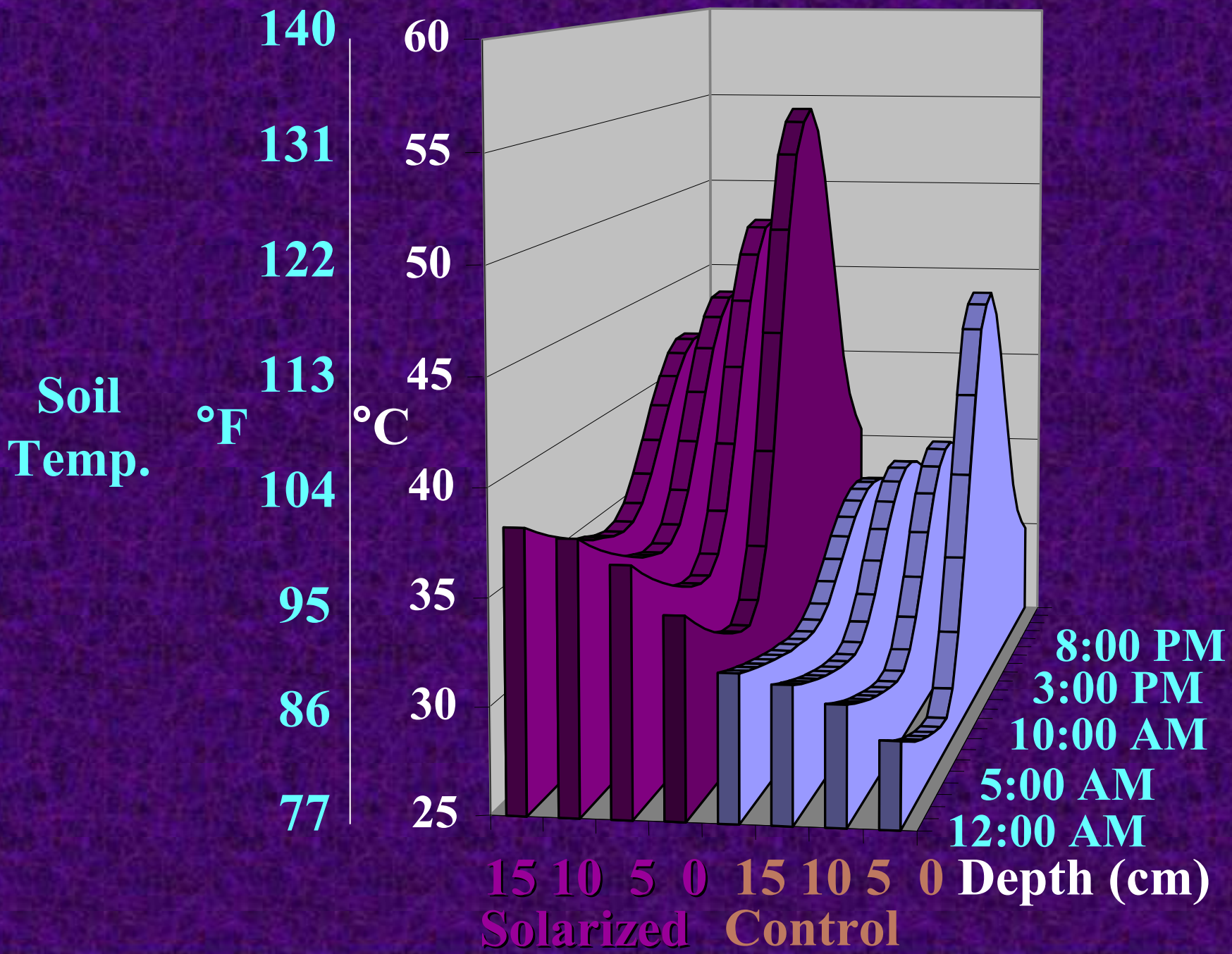
Research: Evaluating the effect of solarization on
Sclerotinia sclerotiorum



SOIL SOLARIZATION



- Forty sclerotia placed in each “bag”.
- Treatments: solarized plots and control plots.
- Soil depth: bags buried at 0, 5, 10, and 15 cm in each plot.
- Bags solarized for 2, 4, and 6 week periods.

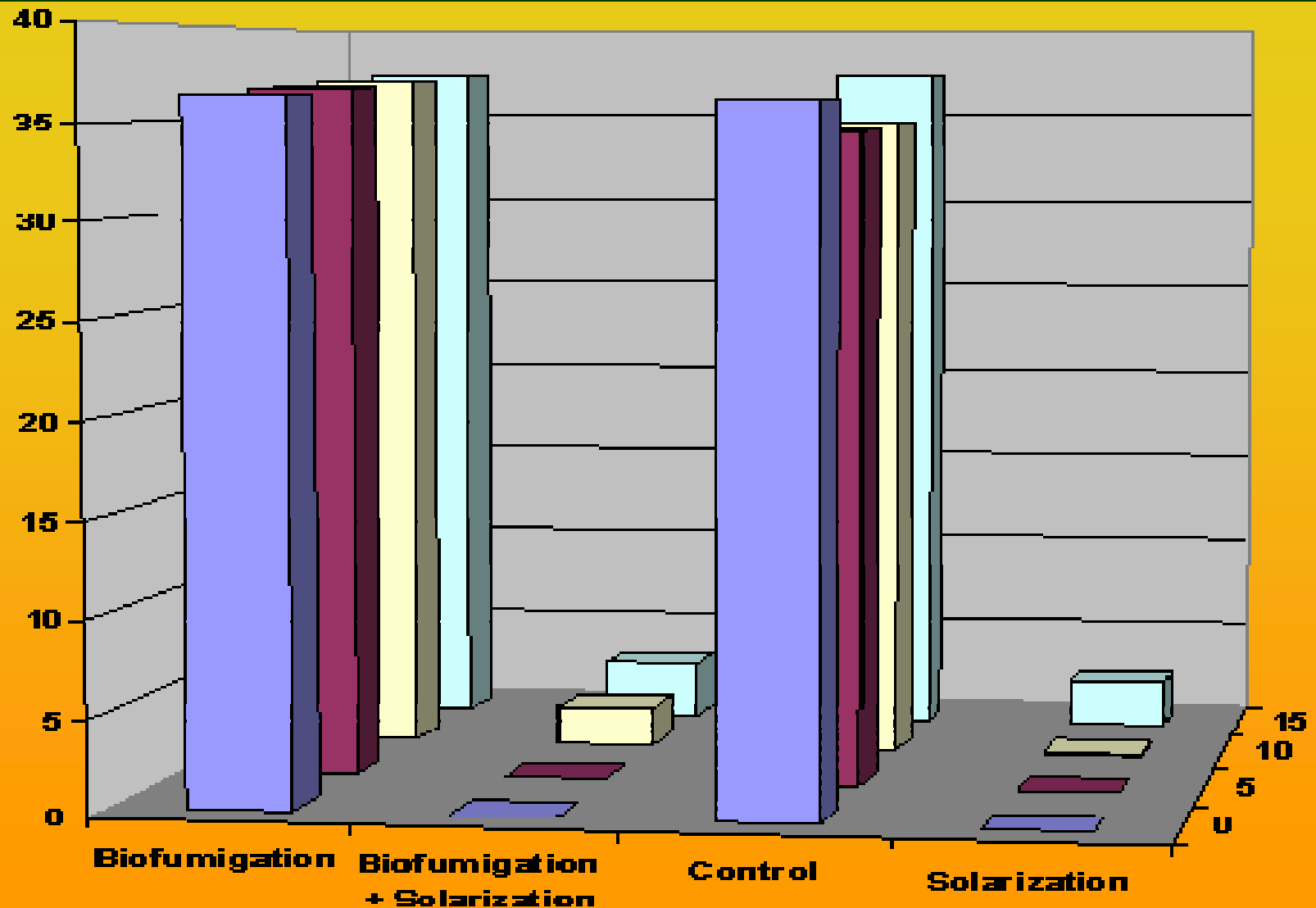


SOIL SOLARIZATION

- Treated sclerotia put in petri dishes with sterilized soil.
- Plates incubated at optimal temperature and light for sclerotia germination.
- Counts of germinated sclerotia recorded.



Number of Germinating Sclerotia (of 40) after 6 Weeks in the Soil



SOIL SOLARIZATION

Our Results:

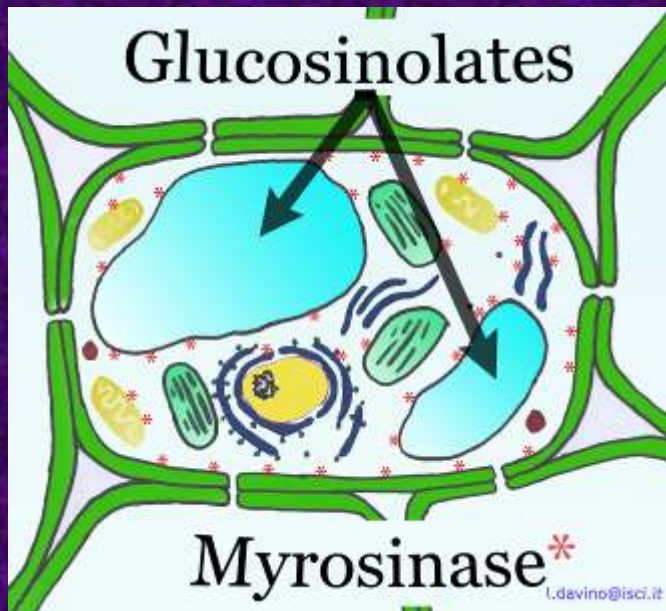
- Effectively decreased the number of live sclerotia (of *S. sclerotiorum*).
- Effectiveness of solarization decreases with depth.
- Effect was reached after 4 weeks of solarization.
- Effectiveness depends on temperatures achieved.
- Soil samples will reveal “active carbon” lost to solarization.



BIOFUMIGATION



Uses a natural defense mechanism of Brassica plants to decrease pest populations in the soil.



BIOFUMIGATION



- Cover crop of mustards at flowering stage maximizes biomass and glucosinolate content.
- Thorough chopping releases more isothiocyanates.
 - Immediate incorporation into soil.
 - Adequate moisture to retain isothiocyanates.

BIOFUMIGATION

Research Questions/Objectives:

- What are the best mustards for biofumigation?
- How susceptible is *S. sclerotiorum* to glucosinolates?
- How much biomass is needed to release the amount of glucosinolates that will control *S. sclerotiorum*?
- What cultural practices can release this amount of glucosinolates into the soil?
- Can we grow mustards in the field, and bring chopped mustards into high tunnel for biofumigation?

What are the best mustards for biofumigation?

- Which mustards produce a lot of biomass in our climate?
- Which mustards have high levels of glucosinolates?
- “Pacific Gold”

Late winter plantings in the high tunnel.

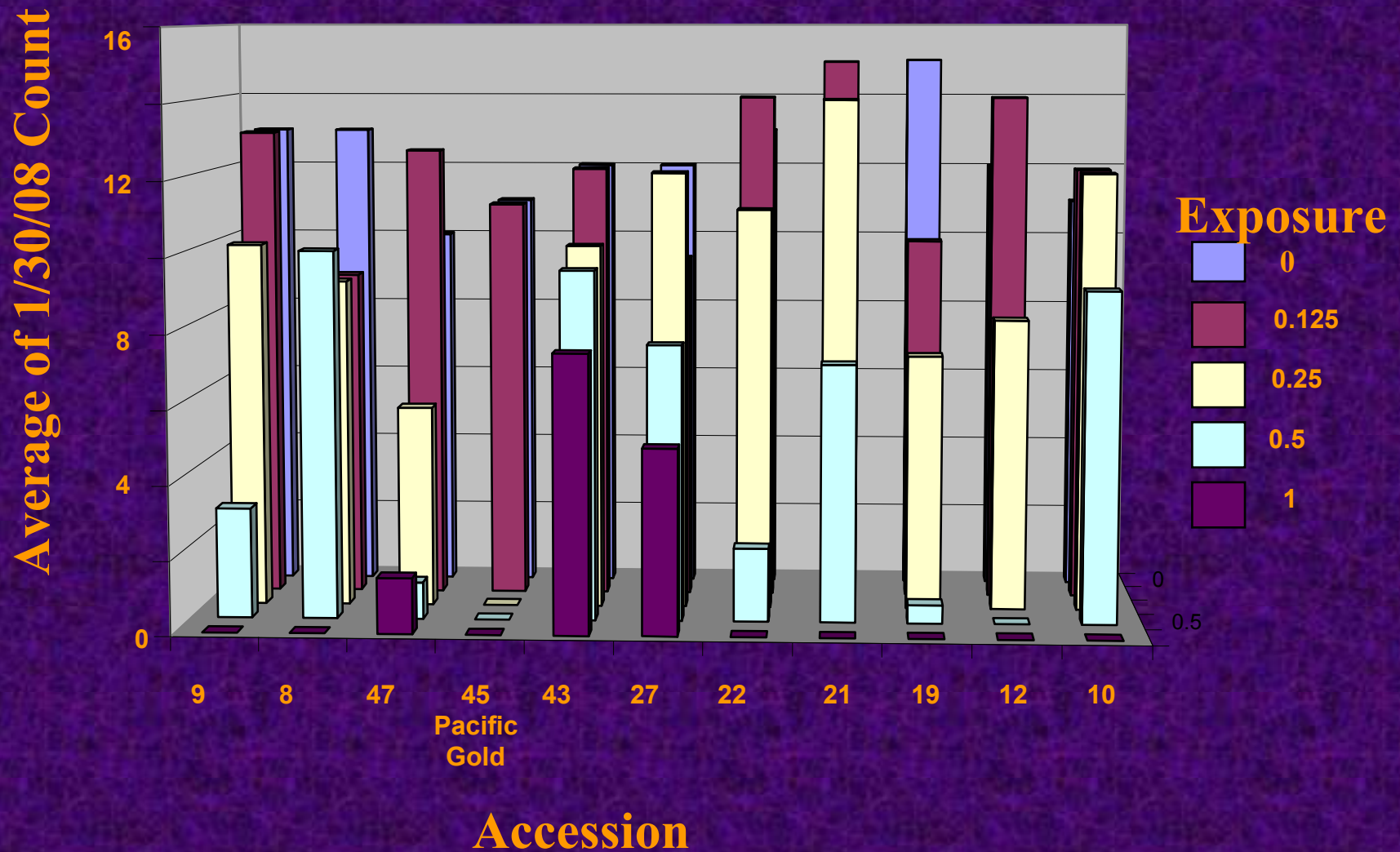


How susceptible is *S. sclerotiorum* to glucosinolates?

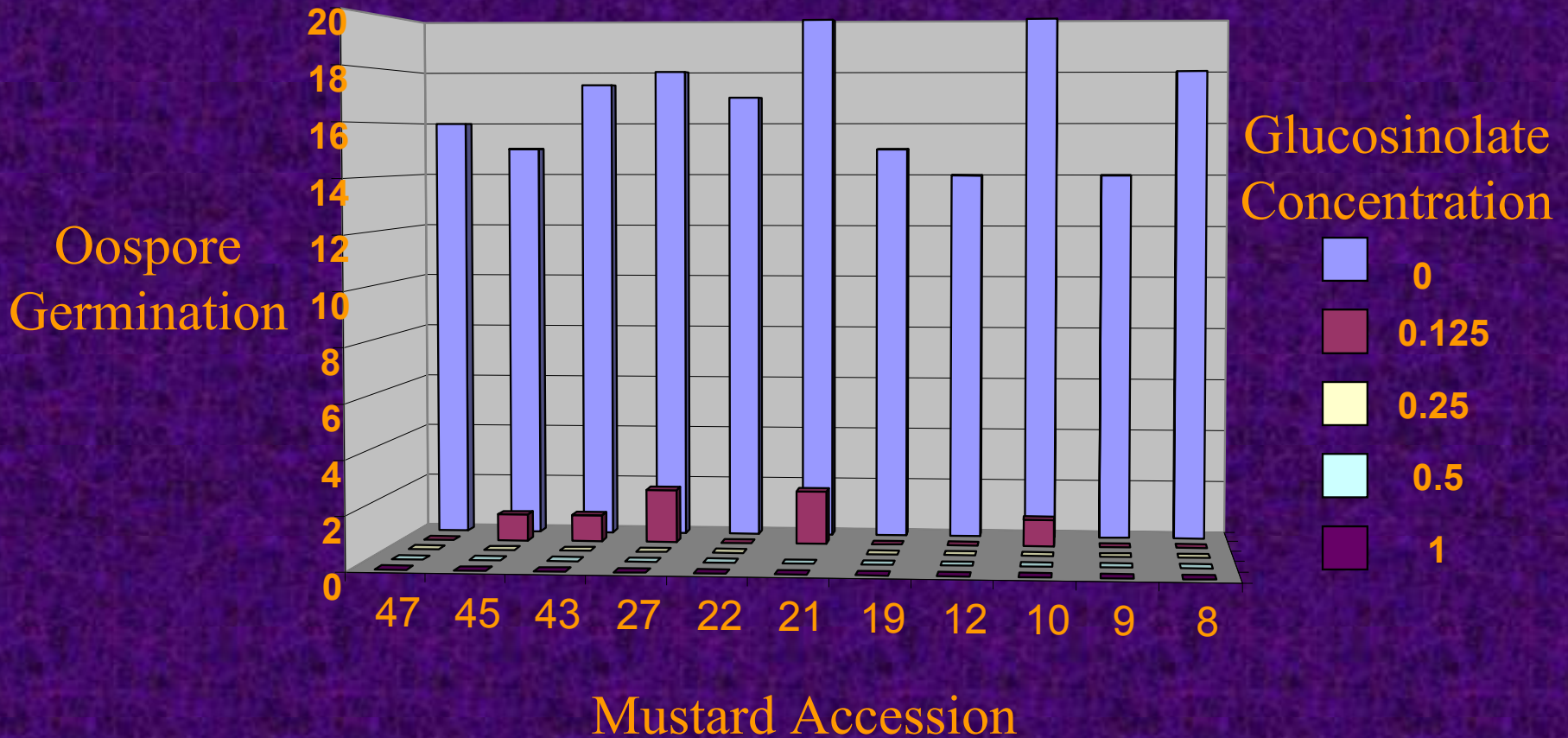
Working with isolated glucosinolates...

- What rate of biofumigation has been successful with other diseases? (Grams of glucosinolates per Petri dish)
- Tested this rate at 2, 1, 0.5, 0.25, and 0X on Petri dishes of *S. sclerotiorum*.
- Found that a the rate (1X) was effective at suppressing sclerotia germination.
- Translated this “lab” rate (glucosinolates per petri dish) to a “field” rate (grams of biomass per square meter of soil) for use in later field studies.

Germination of *S. sclerotiorum* After Exposure to Glucosinolate Concentrations



Oospore Germination of *P. capsici* After Exposure to Glucosinolate Concentrations



What cultural practices can release this amount of glucosinolates into the soil?



BIOFUMIGATION

Remaining questions:

- *What is the effect of growing a cover crop of mustards inside a high tunnel on *S. sclerotiorum*?*
- *How does this compare to a cover crop that does not produce glucosinolates?*
- *Silly researchers...? Do mesh bags protect sclerotia from biofumigation?*

BIOFUMIGATION

- Glucosinolate extracts kill *S. sclerotiorum* in the lab, but we do not know if/how glucosinolates are effective in the field.
- Disease suppression following a biofumigant crop could be due to higher levels of organic matter, glucosinolate breakdown (biofumigation), other factors involved with mustard growth/decomposition, or some combination of these.
- Pacific Gold and other mustards are strong cover crops, with large biomass and pollen production, which can be integrated into a whole-farm pest management approach.

BIOFUMIGANTS

When used as a cover crop, potential benefits include:

- *Reduction in soil-dwelling pest populations following exposure to glucosinolates.*
- *Increase in soil organic matter.*
- *Beneficial insect habitat and pollen/nectar source.*

