Managing *Sclerotinia sclerotiorum* in high tunnels with biofumigation and solarization

Michael Bomford, KSU
Paul Vincelli, UK
George Antonious, KSU
Kenny Seebold, UK

KENTUCKY STATE UNIVERSITY
UK UNIVERSITY OF KENTUCKY
College of Agriculture

Outline

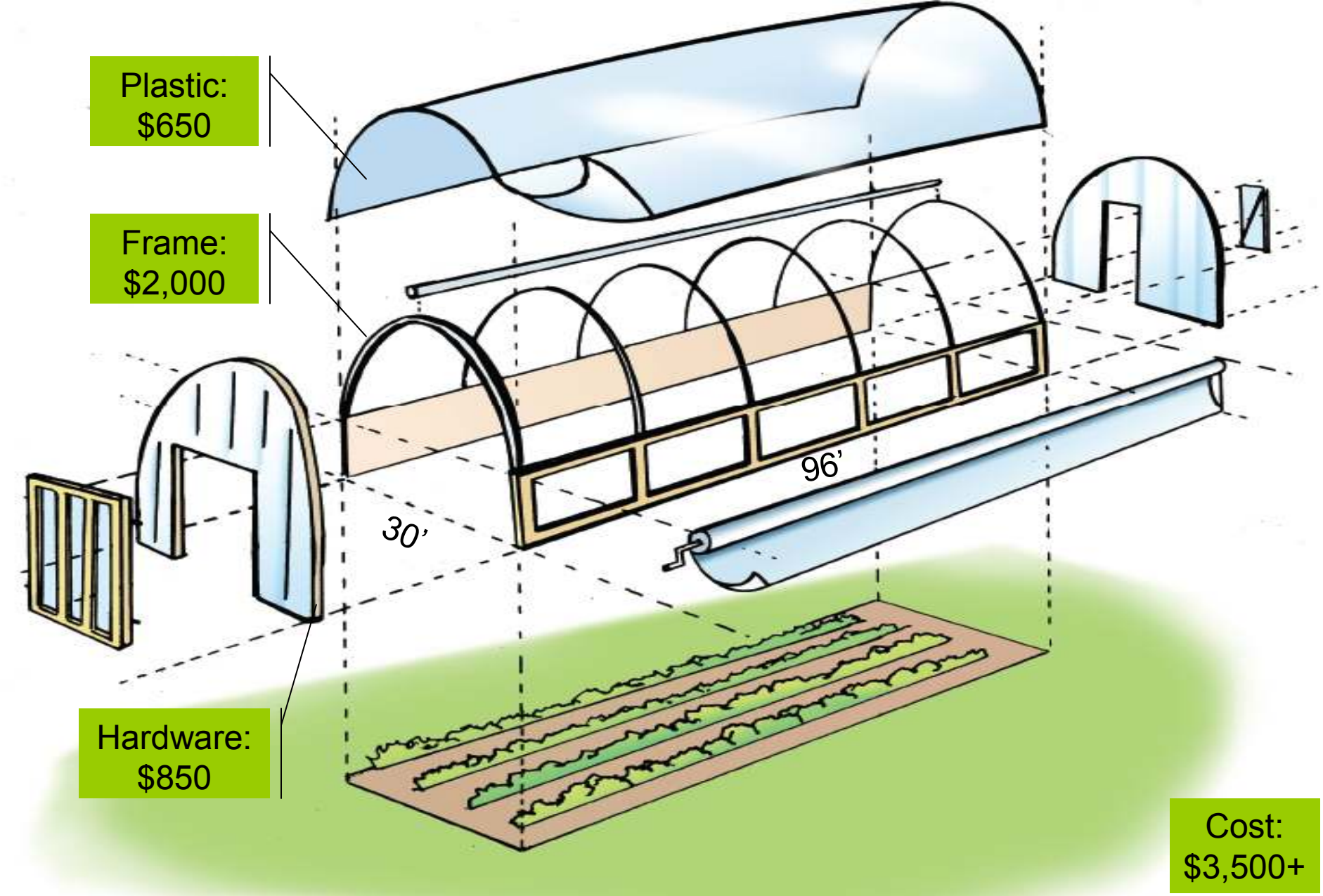
- High tunnels
- *Sclerotinia sclerotiorum* and *Phytophthora capsici*
- Biofumigation and solarization
- Experiments
  - Glucosinolate production
    - Effects of genetics, growing conditions, planting date
  - Bioassays
    - Petri dish, soil-based
  - High tunnel field study

High Tunnels

Solar

- Unheated greenhouses
- Metal quonset frame
- Plastic cover

- Passive ventilation
- Soil-based production
- Simple
- Cheap



Lewis Jett. 2006. High Tunnel Melon and Watermelon Production. University of Missouri Extension, M173

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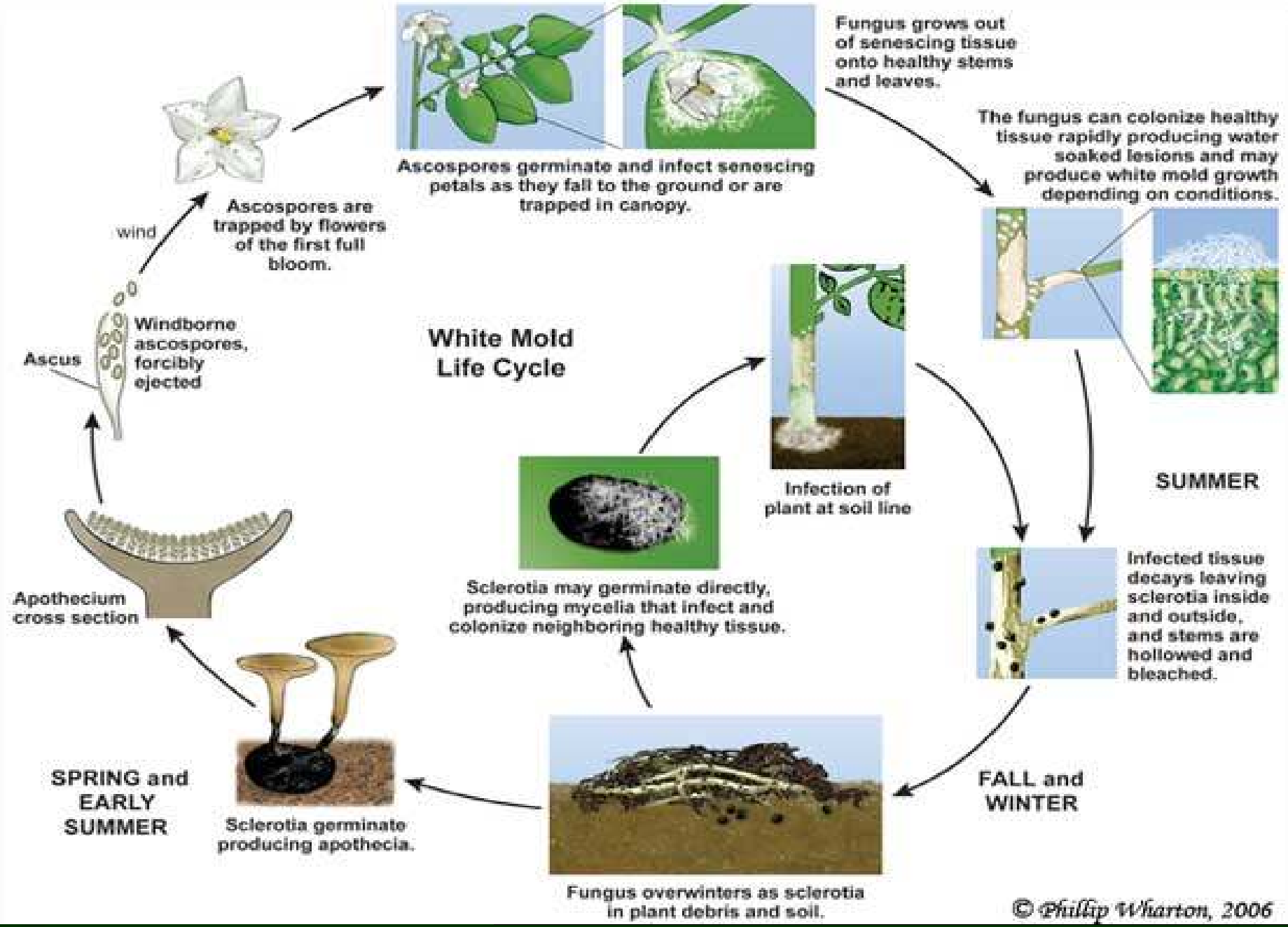
Sclerotinia sclerotiorum

- Thrives in cool, moist conditions
- Persists in soil as sclerotia

- White mold of lettuce
- Broad host range
- Problem in high tunnels



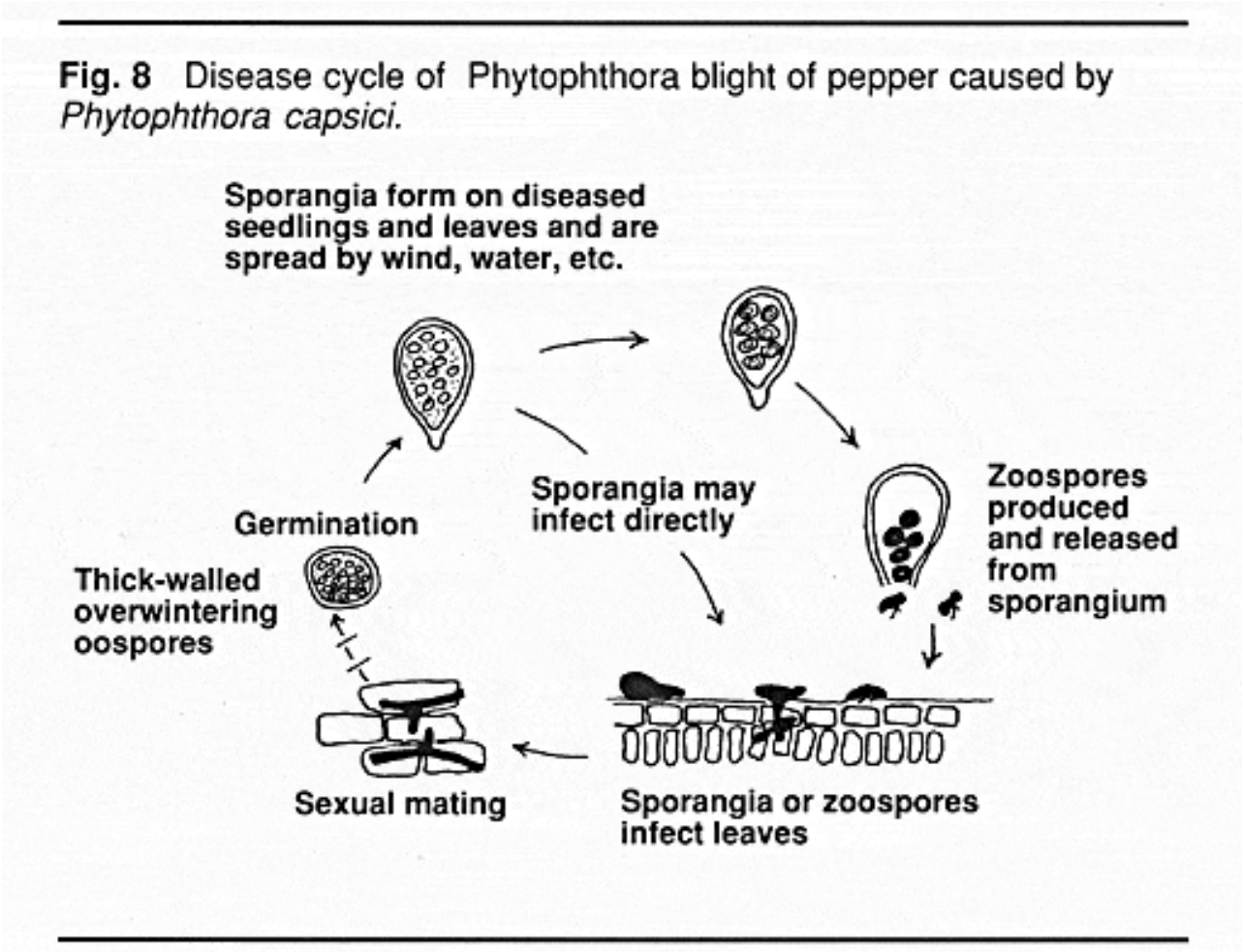
Philip Wharton. White Mold. Michigan State University.
http://www.potatodiseases.org/whitemold.html

Phytophthora capsici

- soil-borne fungal pathogen of peppers, tomatoes, melons, cucumbers, and squash
- severe losses
- recent problem in Kentucky field vegetable production

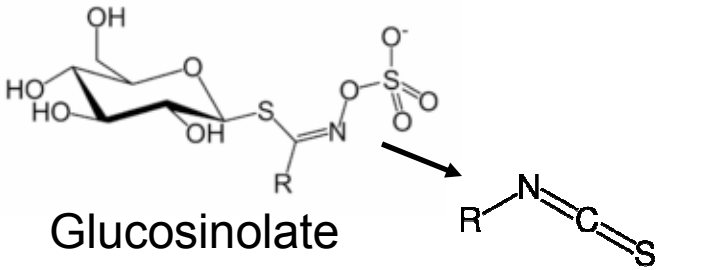
Phytophthora capsici

- Grows best between 25-30°C
- Forms microscopic spores called sporangia
- Forms thick-walled over-wintering oospores after mating



Organic management options

- Biofumigation
  - General: Use of volatile chemicals produced by plants to control or suppress soil-borne pests and diseases
  - Specific: Soil incorporation of brassicas, which contain glucosinolates that break down into volatile isothiocyanates



Glucosinolate

Isothyocyanate

- Solarization
  - Using clear plastic over the soil surface to capture solar energy, heat soil, and kill weed seeds and soil-borne pests and diseases

Glucosinolate production

- Objective
  - Identify suitable brassica cover crop
- Methods
  - Evaluated 47 brassica accessions for suitability as a cover crop in high tunnel (winter) and field (spring)
    - *Brassica juncea* (Indian mustard),
    - *B. napus* (Rape),
    - *B. carinata* (Ethiopian mustard),
    - *Eruca sativa* (Arugula)
  - Recorded survival, days to maturity, biomass production
  - Determined glucosinolate content of most promising accessions (Antonious et al 2009)

Materials & Methods

Ten accessions that demonstracted relative cold tolerance, rapid maturity, and superior biomass production were selected from 48 accessions of the National Germplasm Repository:

Ames 8660	*Brassica juncea*	Indian mustard
Ames 8674	*Brassica juncea*	
Ames 8709	*Brassica juncea*	
Ames 8887	*Brassica juncea*	
PI-120923	*Brassica juncea*	
PI-603015	*Brassica juncea*	
Pacific gold	*Brassica juncea*	
PI-169083	*Brassica napus*	Oil seed rape
PI-633215	*Eruca sativa*	Arugula
Ida gold	*Brassica campestris*	Field mustard

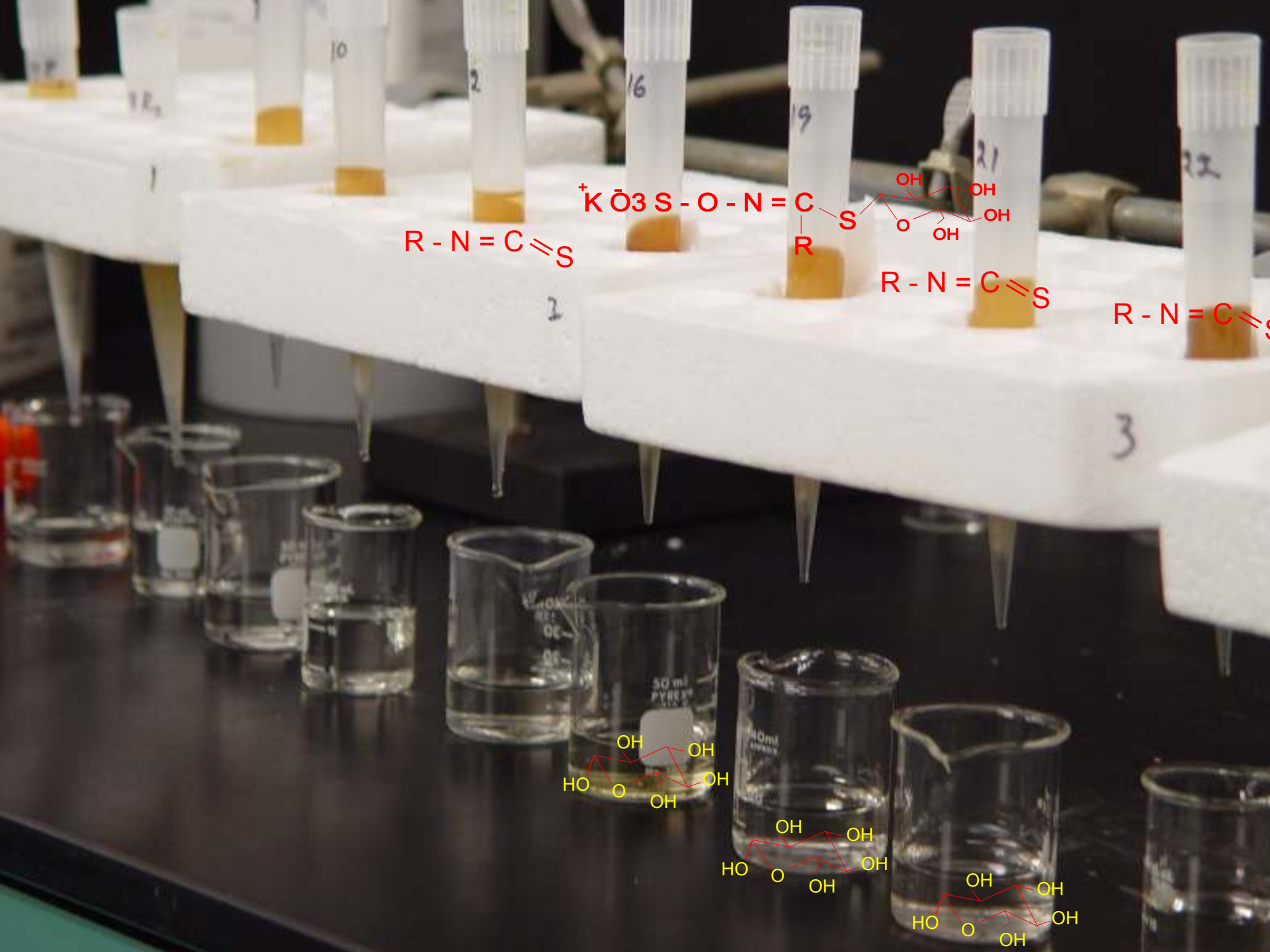
Greenhouse

High Tunnels

Field

Analysis of Glucosinolates

- Extraction using boiling methanol
- Clean-up using celite column
- Separation by anion-exchange resin “Sephadex”
- Hydrolysis with Thioglucosidase
- Quantification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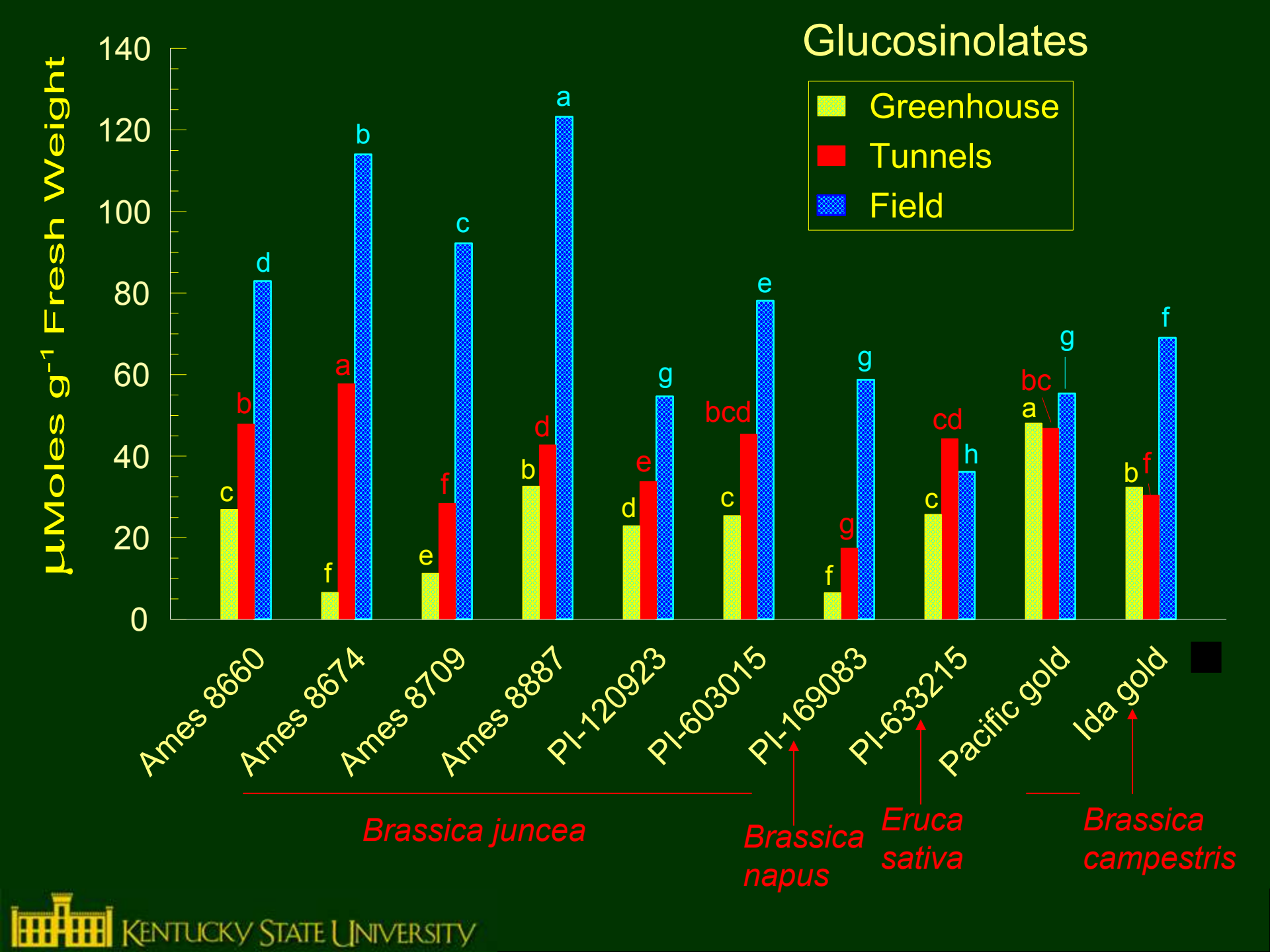
Glucosinolates
Greenhouse
Tunnels
Field
µMoles g-1 Fresh Weight
140
120
100
80
60
40
20
0
Ames 8660
Ames 8674
Ames 8709
Ames 8887
PI-120923
PI-603015
PI-169083
PI-633215
Pacific gold
Ida gold
Brassica juncea
Brassica napus
Eruca sativa
Brassica campestris
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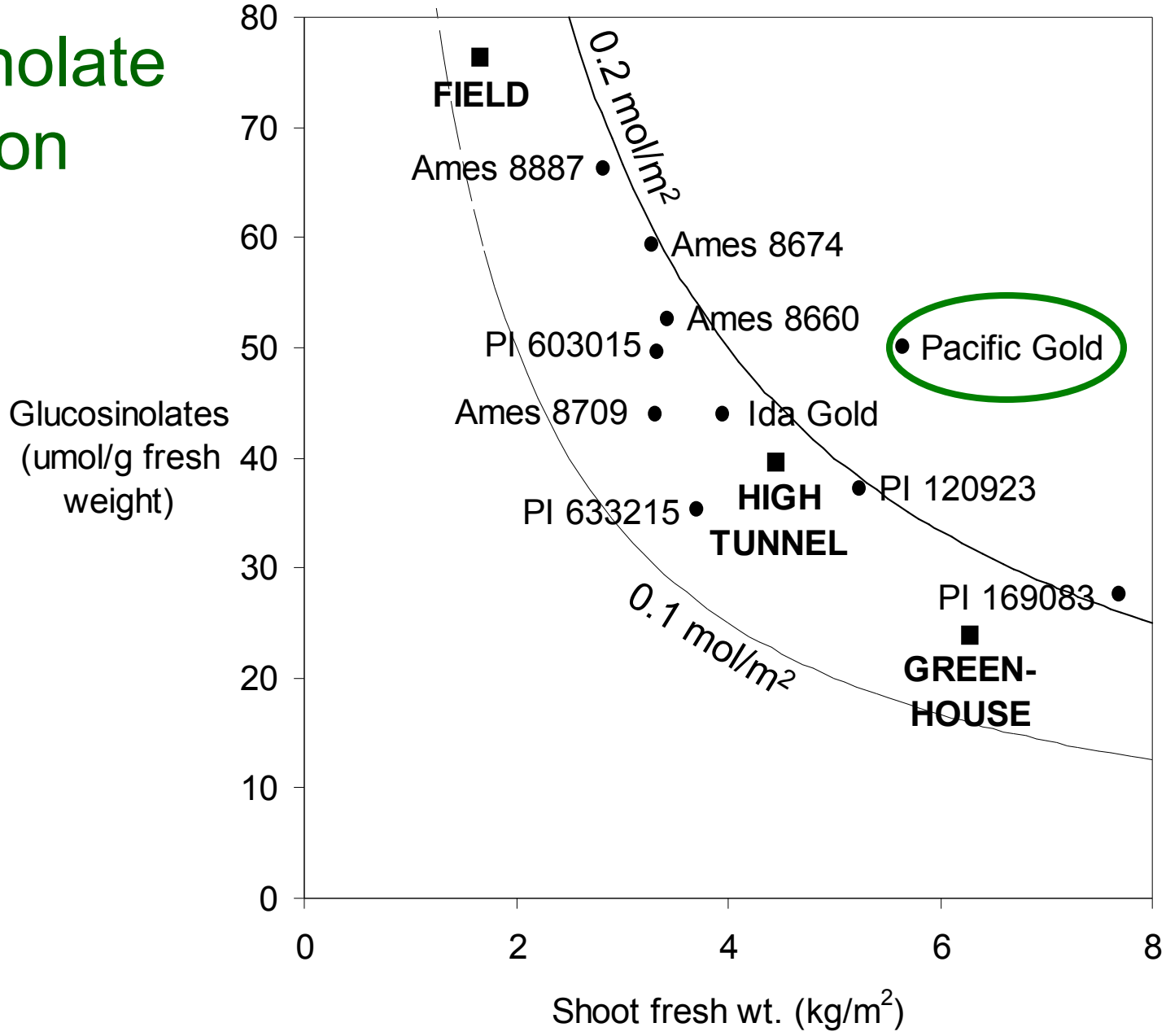
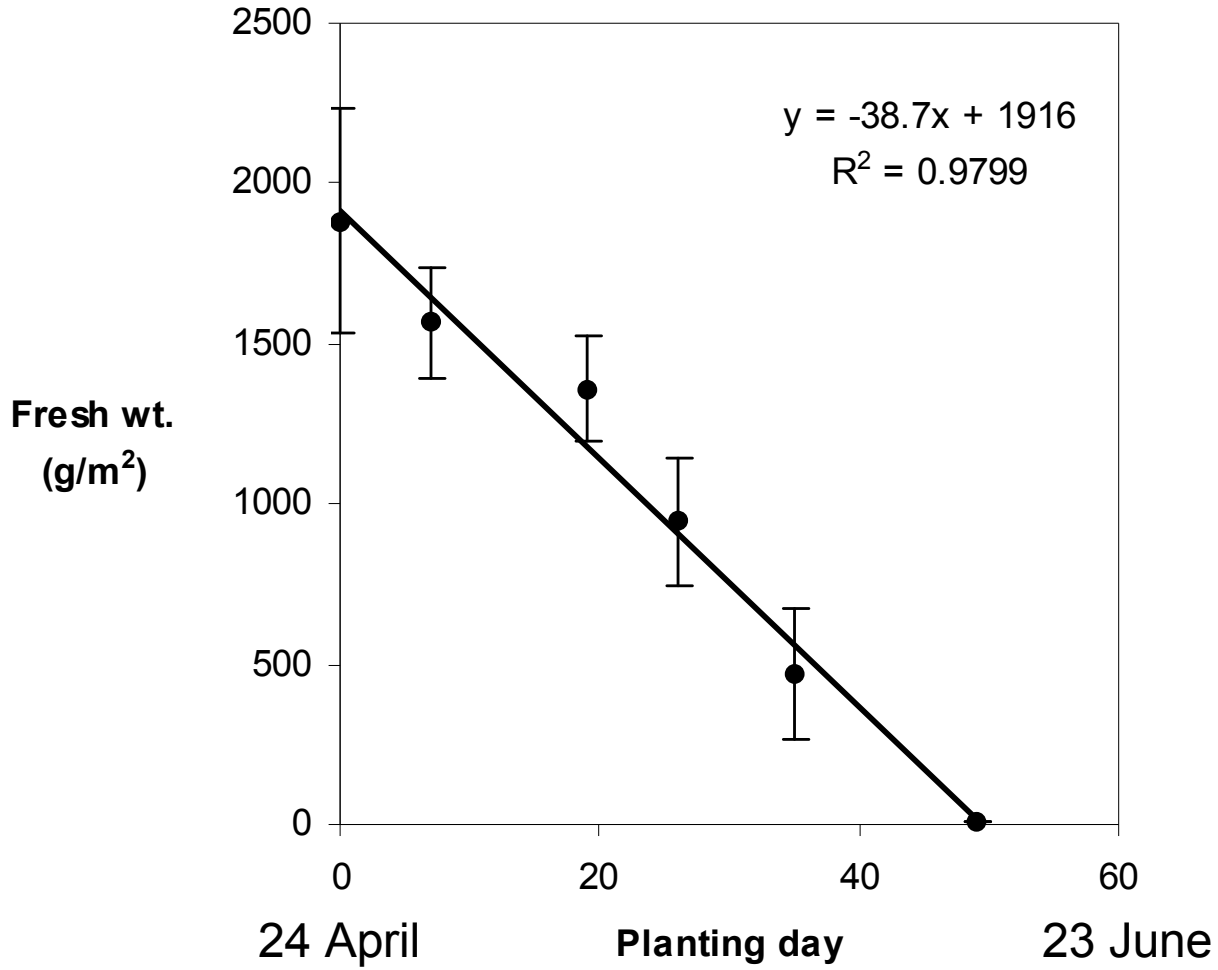
Glucosinolate production



- George Antonious, Michael Bomford and Paul Vincelli. 2009. Screening Brassica Species for Glucosinolate Content. *Journal of Environmental Science and Health*. Part B: Pesticides.

Effect of planting date on field biomass production

- Pacific Gold mustard direct-seeded in field at weekly intervals, weather permitting
- Above-ground biomass collected and weighted at flower initiation



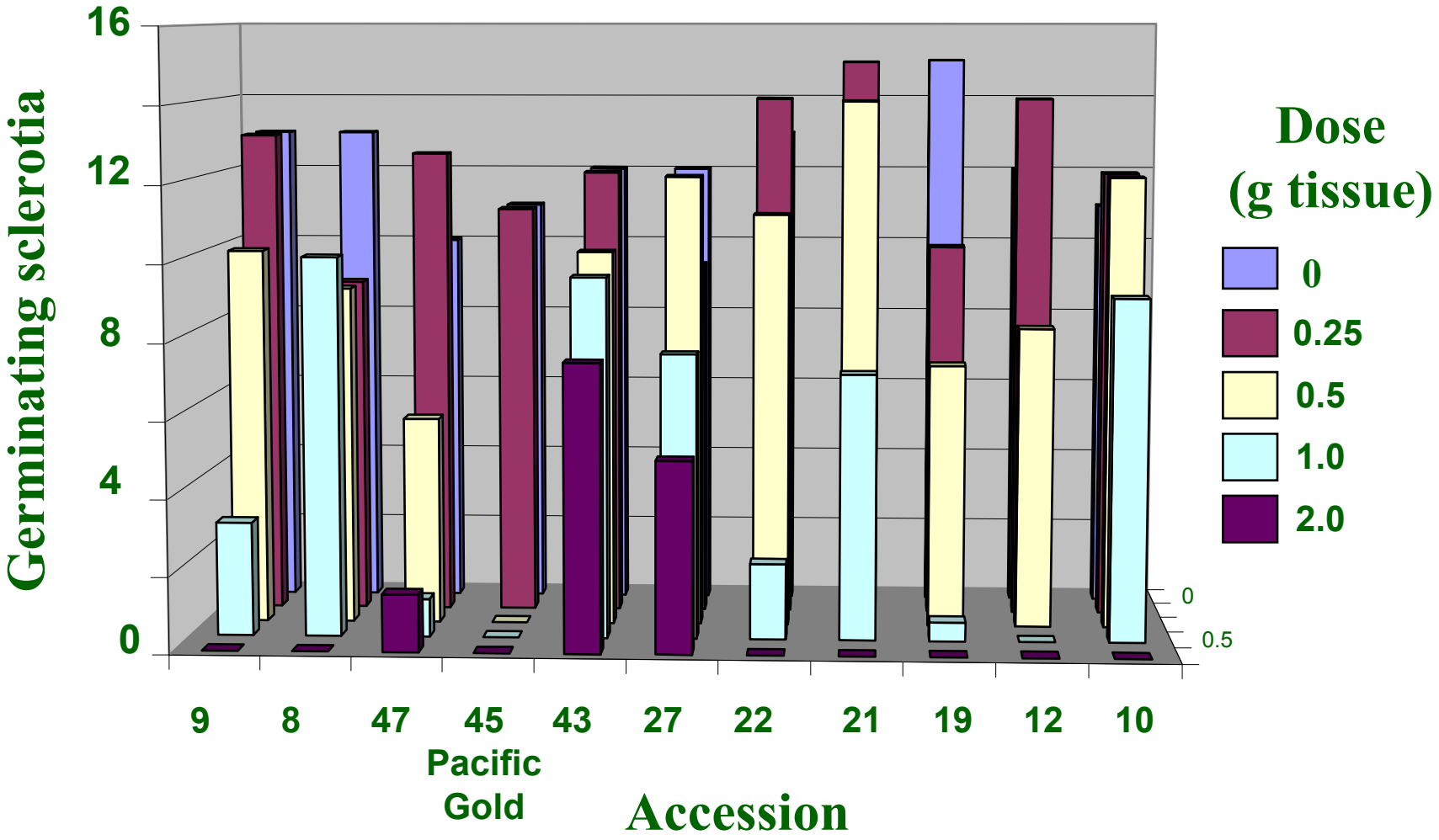
Germination assay

- MeOH tissue extract
  - 0, 0.25, 0.5, 1.0, and 2.0 g f.w.
- Placed in scintillation vials for 24 h with
  - equivalent amount of myrosinase
  - 15 *S. sclerotiorum* sclerotia
  - sterile soil (4 mL total)
- Plated onto Petri dishes with 40 mL sterile soil for 6 wk germination at 16 °C

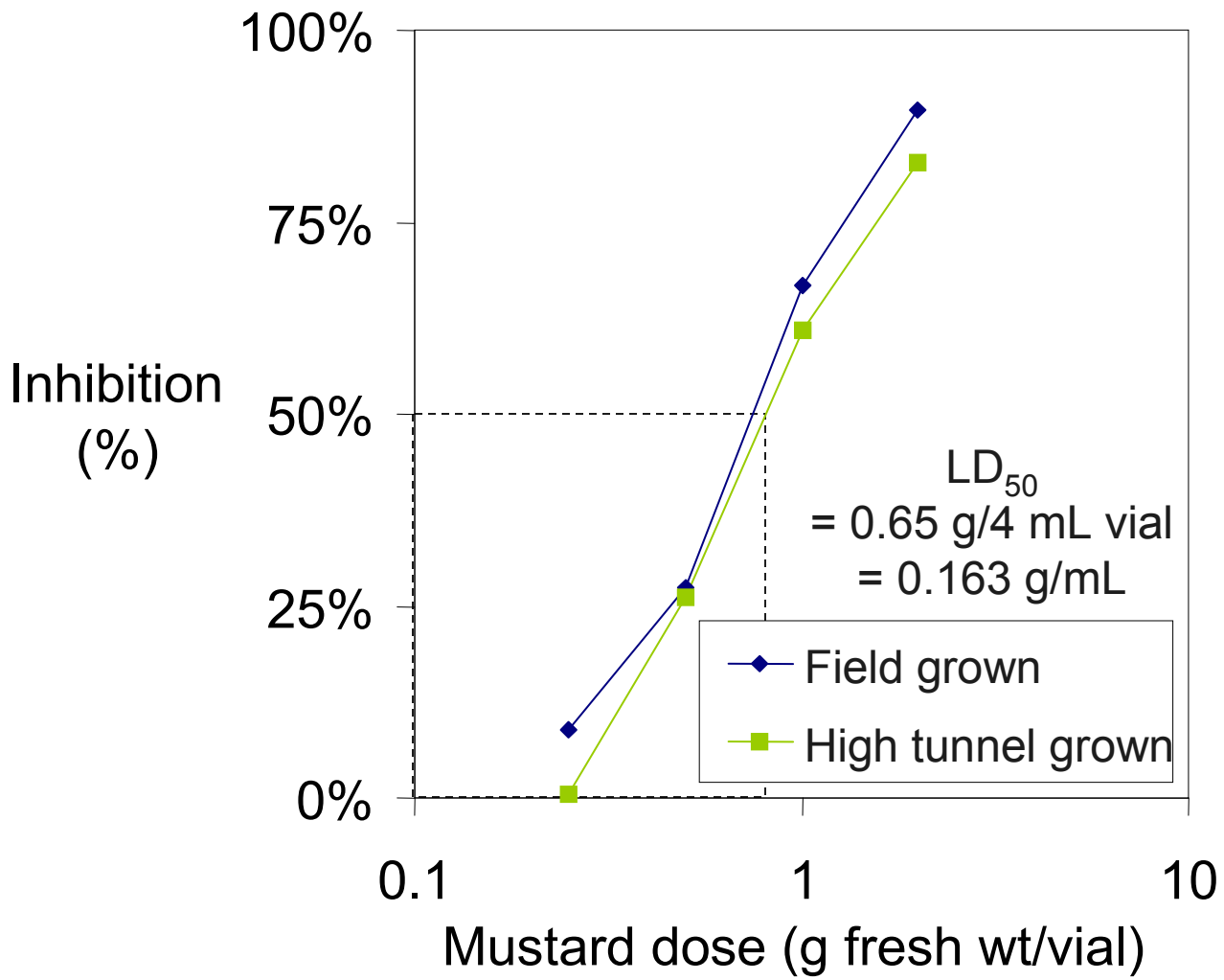
ID	Accession	Species
8	Ames 8657	*B. juncea*
9	Ames 8660	*B. juncea*
10	Ames 8674	*B. juncea*
12	Ames 8754	*B. juncea*
19*	PI 120923	*B. juncea*
21	PI 180417	*B. juncea*
22	PI 603015	*B. juncea*
27*	PI 169083	*B. napus*
43*	PI 633215	*Eruca sativa*
45	Pacific Gold	*B. juncea*
47*	Ida Gold	*B. campestris*

*Field-grown accession tested in addition to high tunnel grown accession

Results: *S. sclerotiorum* Germination (of 15) After Exposure to Mustard Extracts



Results: *S. sclerotiorum* Inhibition



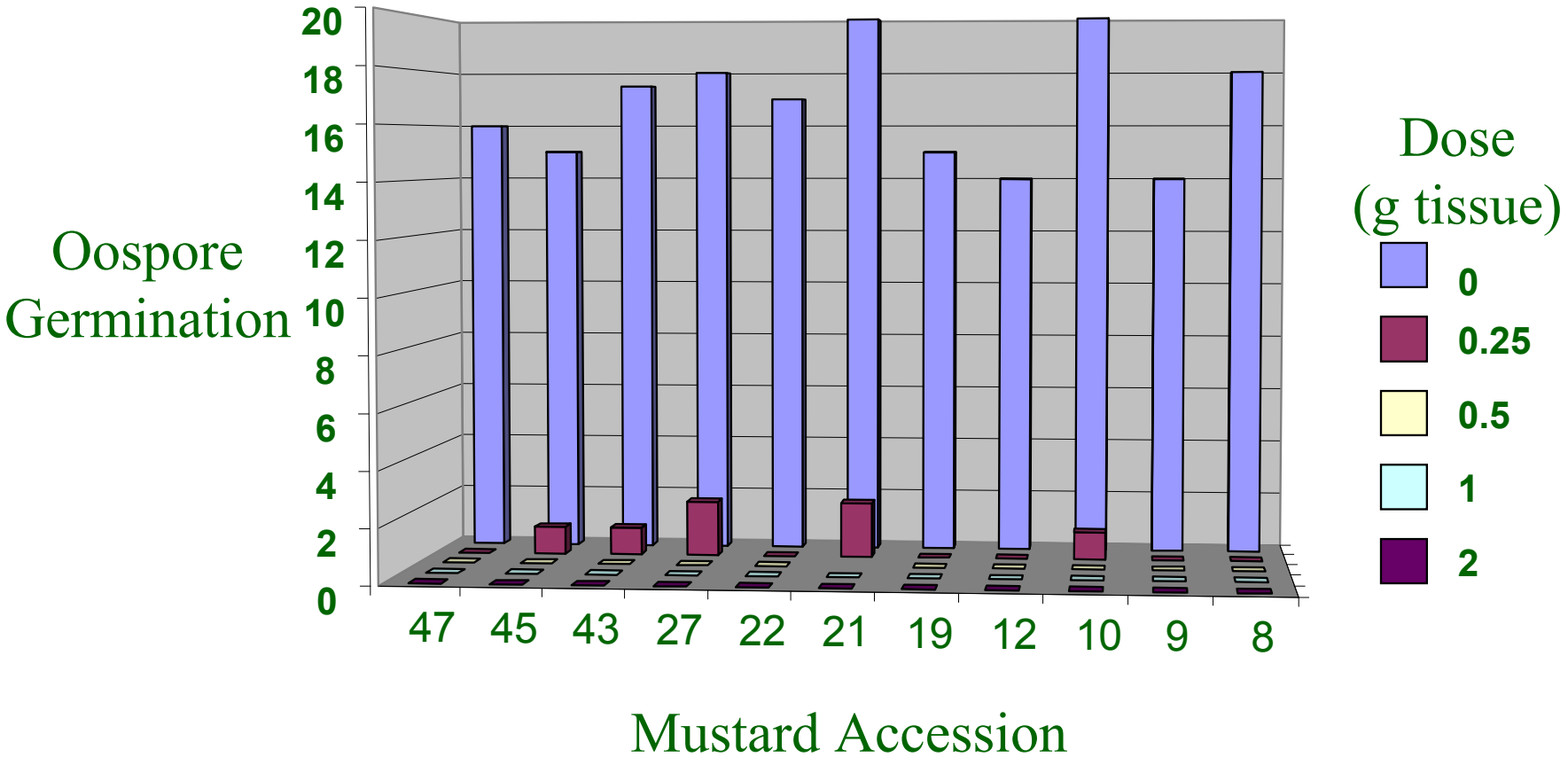
Phytophthora capsici assay

- MeOH tissue extract
  - 0, 0.25, 0.5, 1.0, and 2.0 g f.w.
- Placed in dark sealed culture flasks for 2 wk with
  - equivalent amount of myrosinase
  - *20 P. capsici* oospores
  - sterile soil (4 mL total)
- Oospore germination tallied

ID	Accession	Species
8	Ames 8657	*B. juncea*
9	Ames 8660	*B. juncea*
10	Ames 8674	*B. juncea*
12	Ames 8754	*B. juncea*
19*	PI 120923	*B. juncea*
21	PI 180417	*B. juncea*
22	PI 603015	*B. juncea*
27*	PI 169083	*B. napus*
43*	PI 633215	*Eruca sativa*
45	Pacific Gold	*B. juncea*
47*	Ida Gold	*B. campestris*

*Field-grown accession tested in addition to high tunnel grown accession

Results: *P. capsici* Oospore Germination (of 20) After Exposure to Mustard Extracts



Petri dish assay conclusions

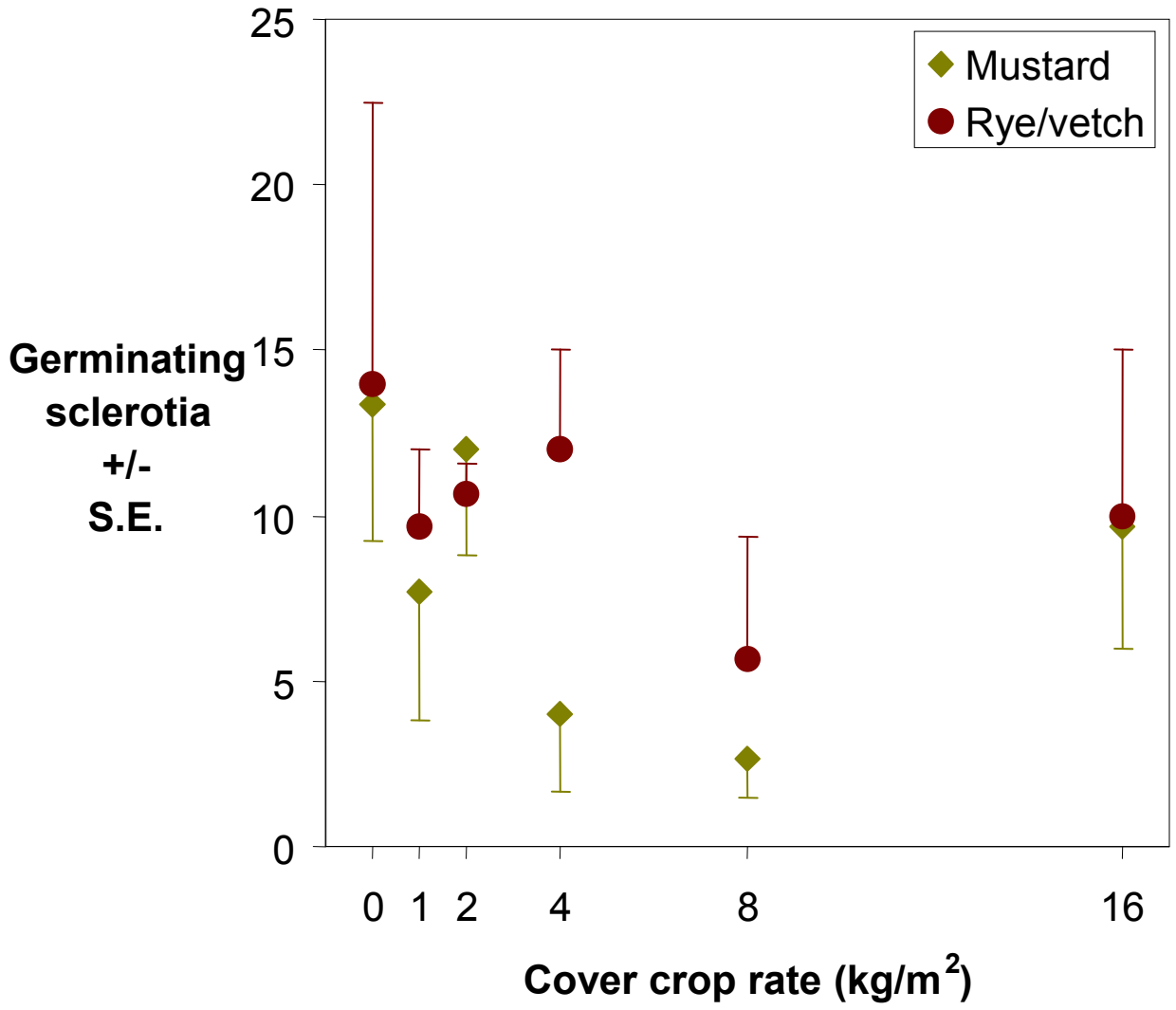
- 24 h exposure to extracts from 0.65 g mustard tissue per 4 mL vial (0.163 g/mL) reduced *S. sclerotiorum* sclerotial germination by 50%
- 'Pacific Gold' gave the best reduction in *S. sclerotiorum* germination
- *P. capsici* oospore germination was completely inhibited by exposure to extracts > 0.5 g mustard tissue / 4 mL substrate (0.12 g/mL).
- *P. capsici* oospores are more sensitive to mustard extracts than *S. sclerotiorum* sclerotia.
- More research is needed to apply these results in the field.

Greenhouse Potting Soil Assay: Methods

- Pacific Gold mustard greens and rye/vetch cover crop harvested and macerated at first flower, 06/12/08
- Cover crops separately incorporated into peat-based potting mix, 15 cm deep
  - 0, 1, 2, 4, 8 and 16 kg m^{-2}
- 3 replicates, completely randomized
- Mesh bag of 50 sclerotia buried in each pot for 4 days
- Sclerotia plated onto Petri dishes with 40 mL sterile soil for 6 wk germination at 16 °C

Greenhouse Potting Soil Assay: Results

- Low germination
- No significant effects:
  - Cover crop
  - Rate (significant if highest rate excluded)



Soil-based *P. capsici* assay: Methods

- Split plot design:
  - Main effect – Presence/Absence of Organica Plant Growth Activator
    - Blend of micro-organisms intended to promote seedling and plant establishment
  - Sub-plots – Presence/Absence of glucosinolates from green manure at 6 incorporation rates
    - Presence: Biofumigation with Pacific Gold mustard greens
    - Absence: Incorporation of rye (*Secale cereale*)/vetch (*Vicia villosa*) cover crop to add organic matter but no glucosinolates
    - Rates: 0, 13.5, 27, 54, 108 and 216 g/L (0-16 kg/m^2)

Methods

- 16 liters of organic planting mix thoroughly mixed with 80 ml of *Phytophthora capsici* inoculant (0.5% volume/volume) and divided into 12 equal portions

Methods

- Green manure harvested at first flower, finely chopped and mixed into planting media at 0, 13.5, 27, 54, 108 or 216 g/L

- Each mixture randomly assigned to fill two of 24 evenly spaced 65 ml cells in each of the 10 seedling plug trays
- A pre-germinated yellow squash (*Cucurbita pepo*) seed planted in each cell

Methods

- Trays randomly assigned to flood irrigation with untreated tap water or tap water treated with 4.2 g/l of Organica Plant Growth Activator

Methods

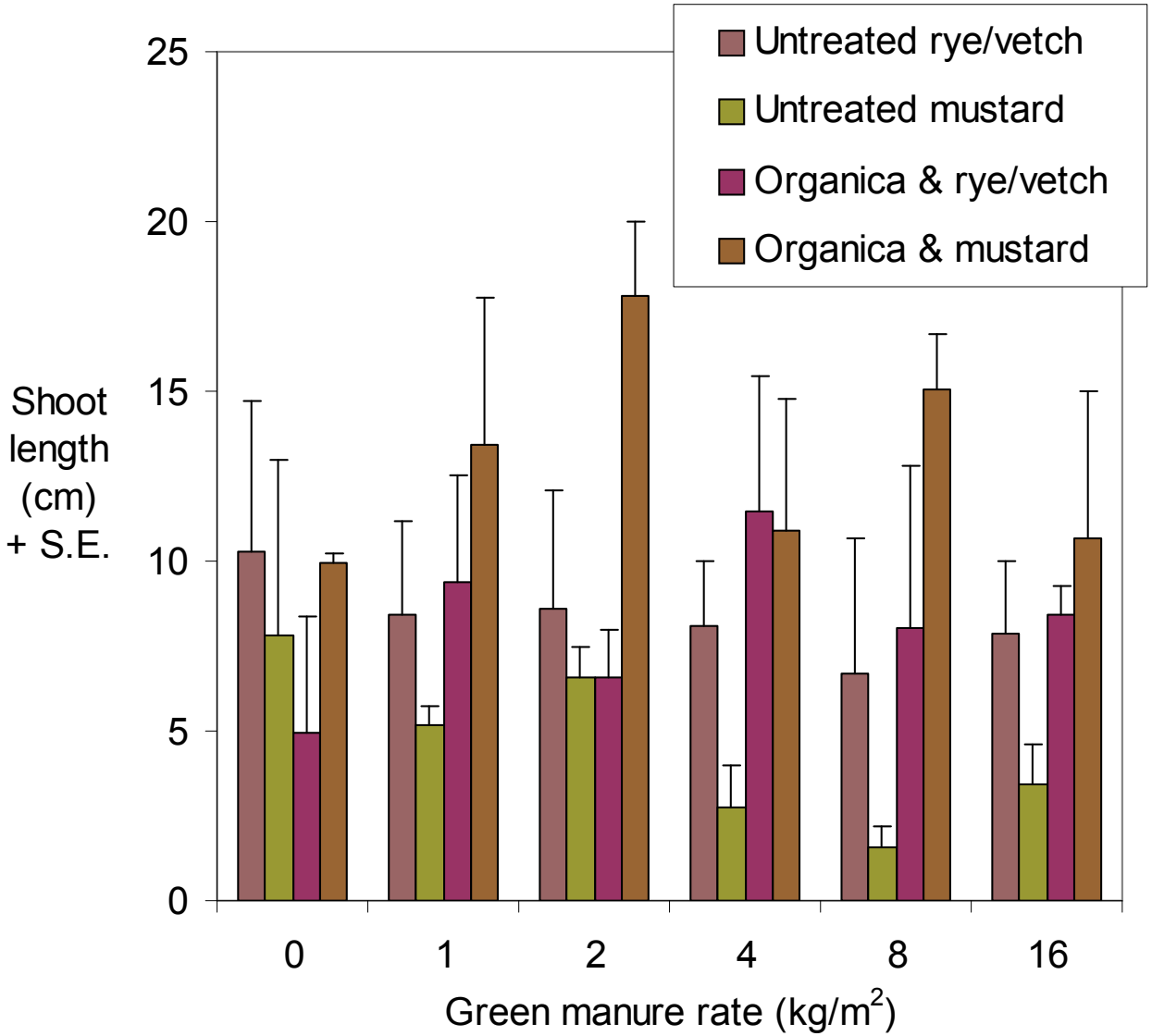
- Trays were partially submerged in the liquid to ensure thorough drenching and incubated for 5 days at 26°C .

Methods

- Seedling survival and shoot length were recorded for each treatment combination in each of 5 replicates

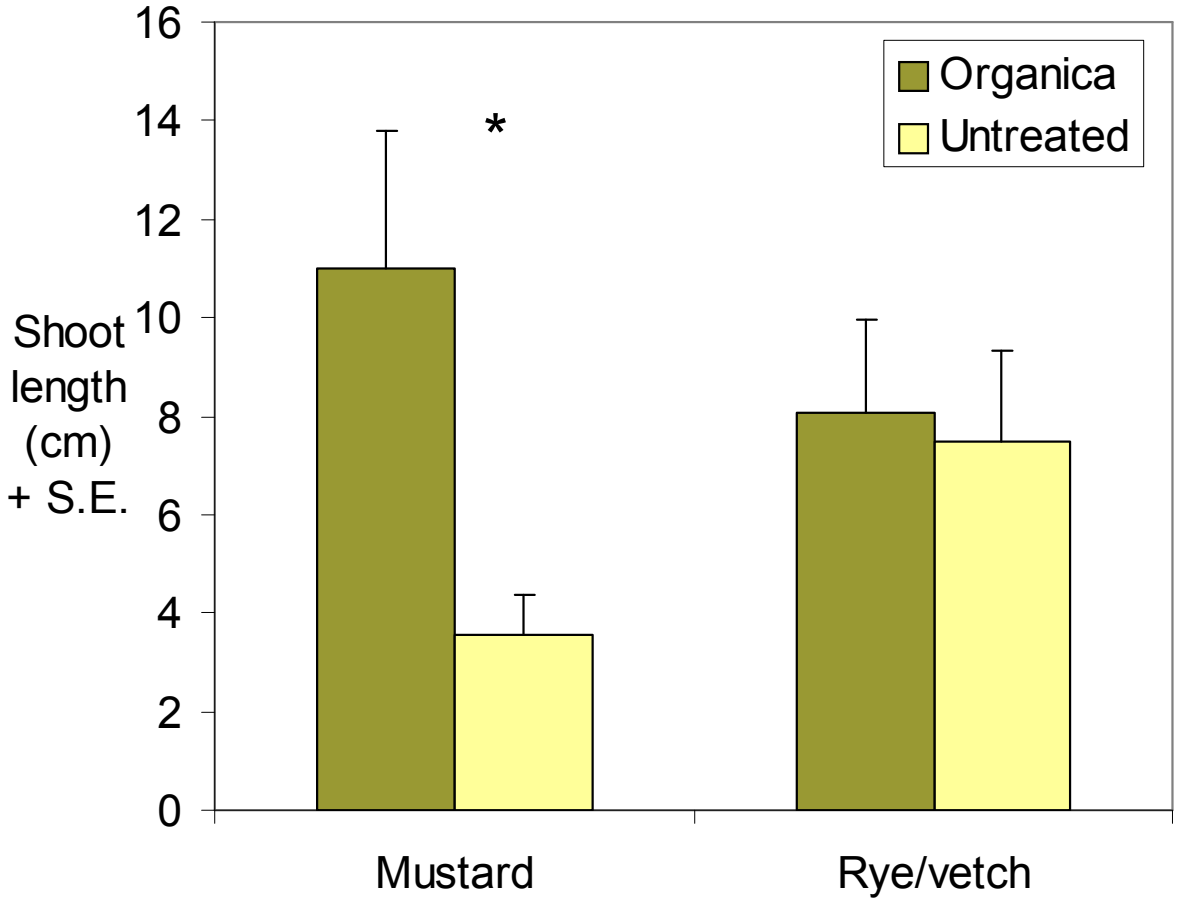
Results

- No significant effect:
  - Cover crop
  - Rate



Results

- Interaction:
  - Cover crop x Organica
- Superior seedling growth with combination of mustard and Organica
- Repeatable?



See video:

http://organic.kysu.edu/SclerotiniaVideo.shtml

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- Contact:
  Michael Bomford
  michael.bomford@kysu.edu
  http://organic.kysu.edu
  502-597-5752

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