New Developments in Suppression of Plant and Animal Diseases with Composts

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A) Suppression of Plant Diseases with Composts

- **1) Root disease**: practiced widely since the 1970's. Methyl bromide was eliminated as a potting mix fumigant and fungicide use was reduced. Biocontrol agent inoculants improved efficacy.

- **2) New Developments:** In the past, composts rarely suppressed foliar diseases. Several biocontrol agents have been identified recently that induce systemic resistance (ISR) in plants. *Trichoderma hamatum* 382, in addition to providing control of soilborne diseases, also induces ISR in plants and reduces foliar disease severity. Thus, pesticide use will be reduced further.

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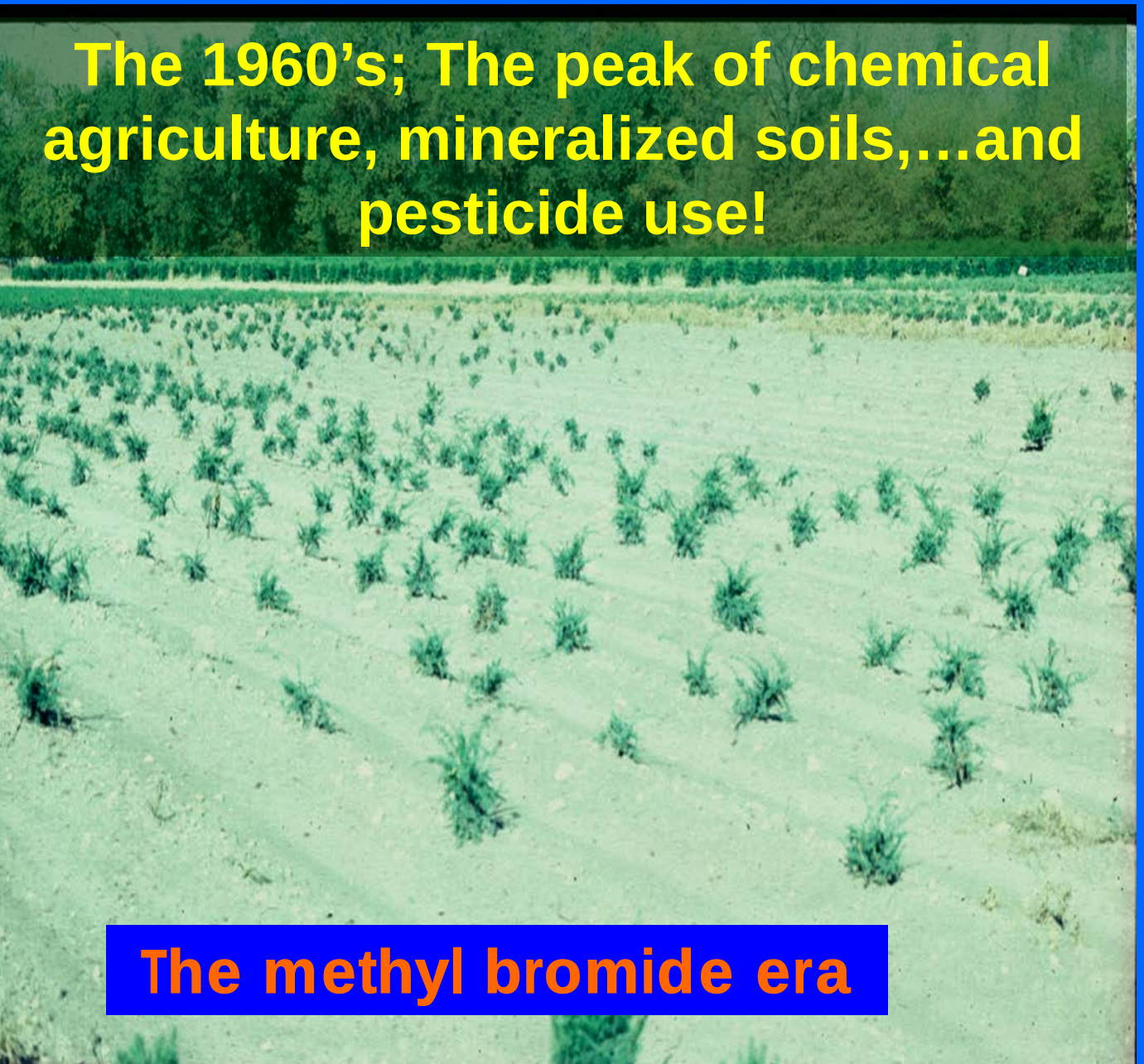
Historical Perspectives



Taxus crop: missing plants in poorly drained soil were killed by *Phytophthora* and by *Thielaviopsis,* another root rot pathogen in the sandy foreground

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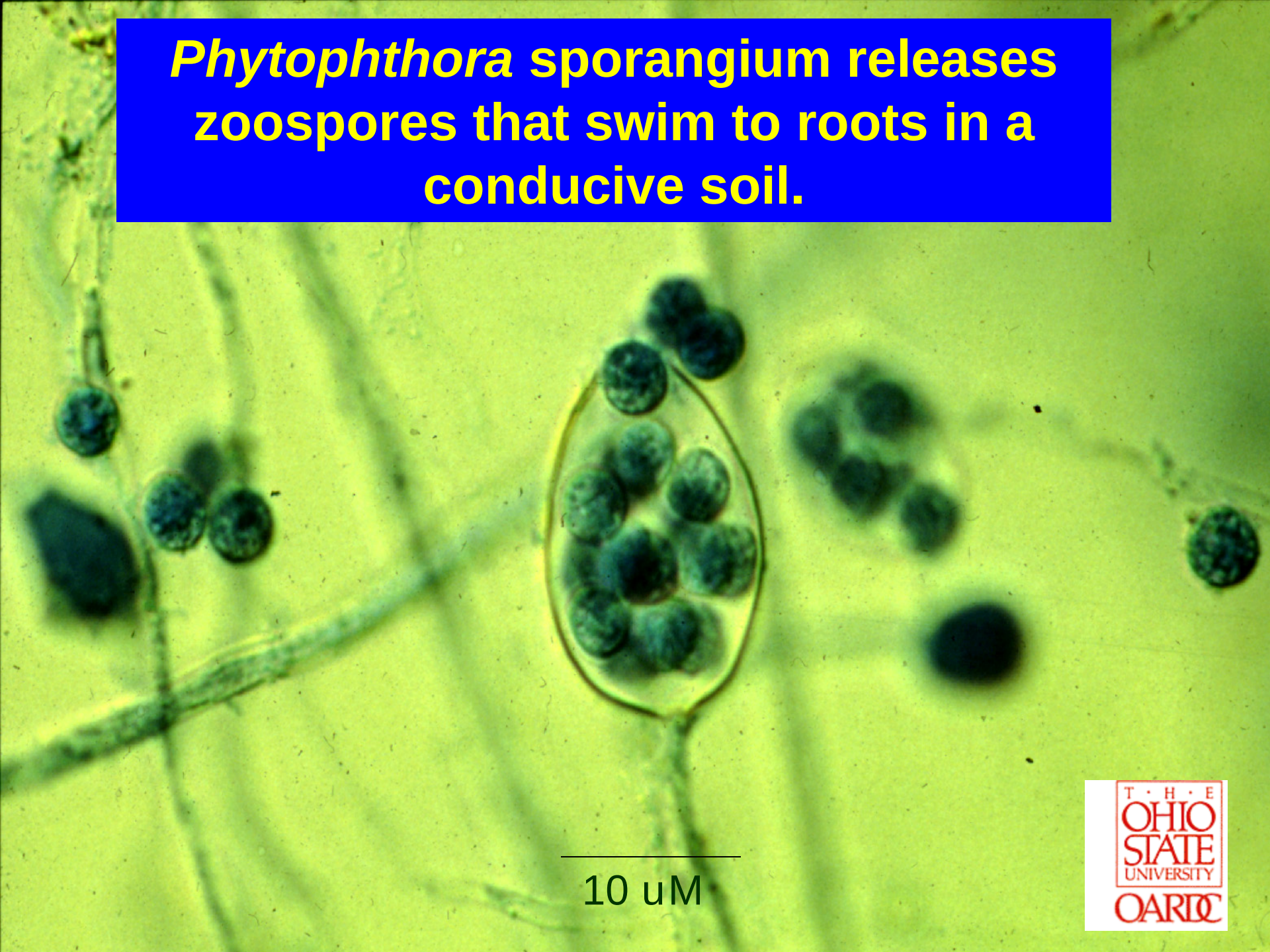
Phytophthora sporangium releases zoospores that swim to roots in a conducive soil.
10 uM
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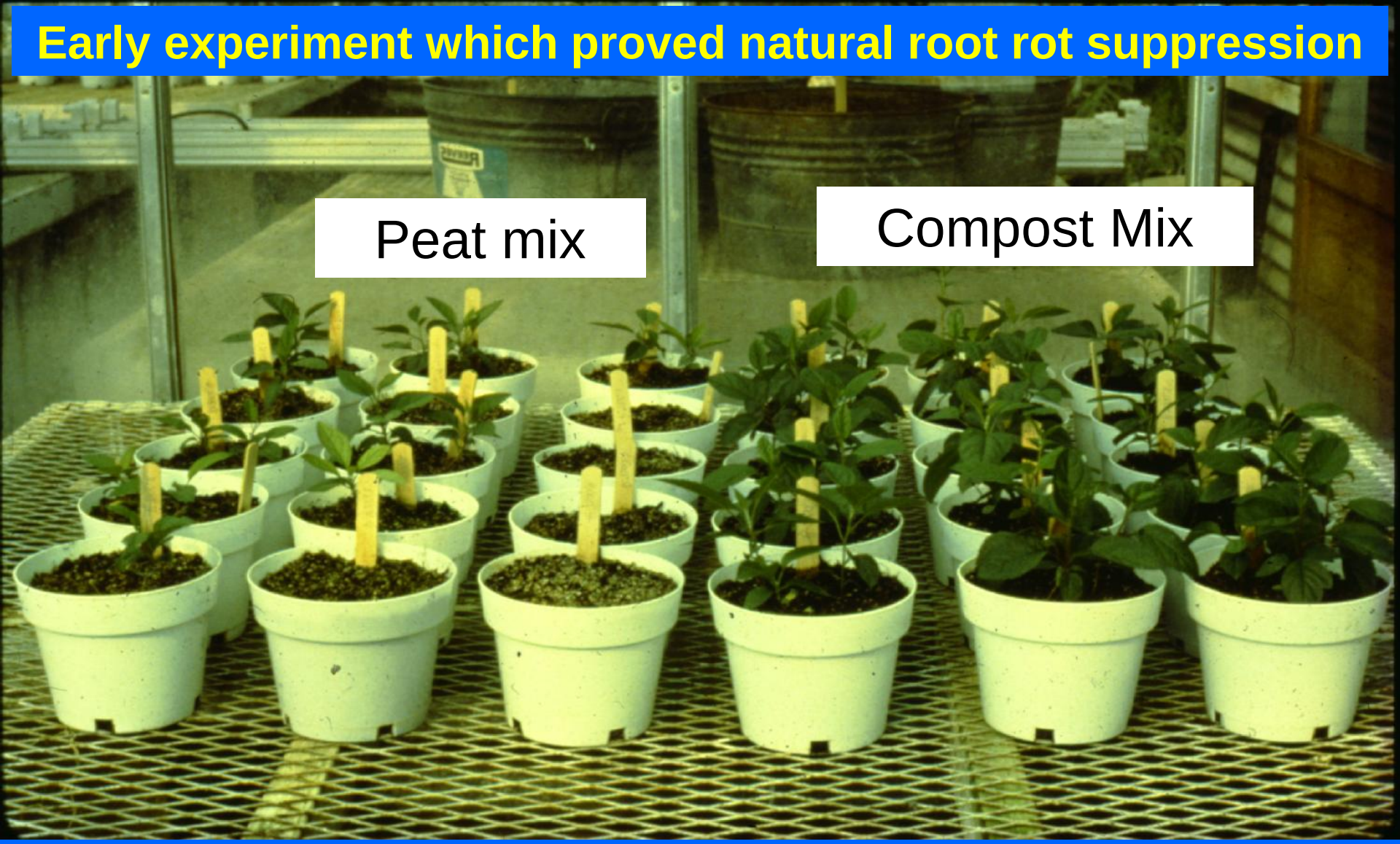
Early experiment which proved natural root rot suppression



Suppression of Phytophthora collar rot on apple seedlings in a compost mix

Spring et al., 1980, Phytopathol. 70:1209-1212

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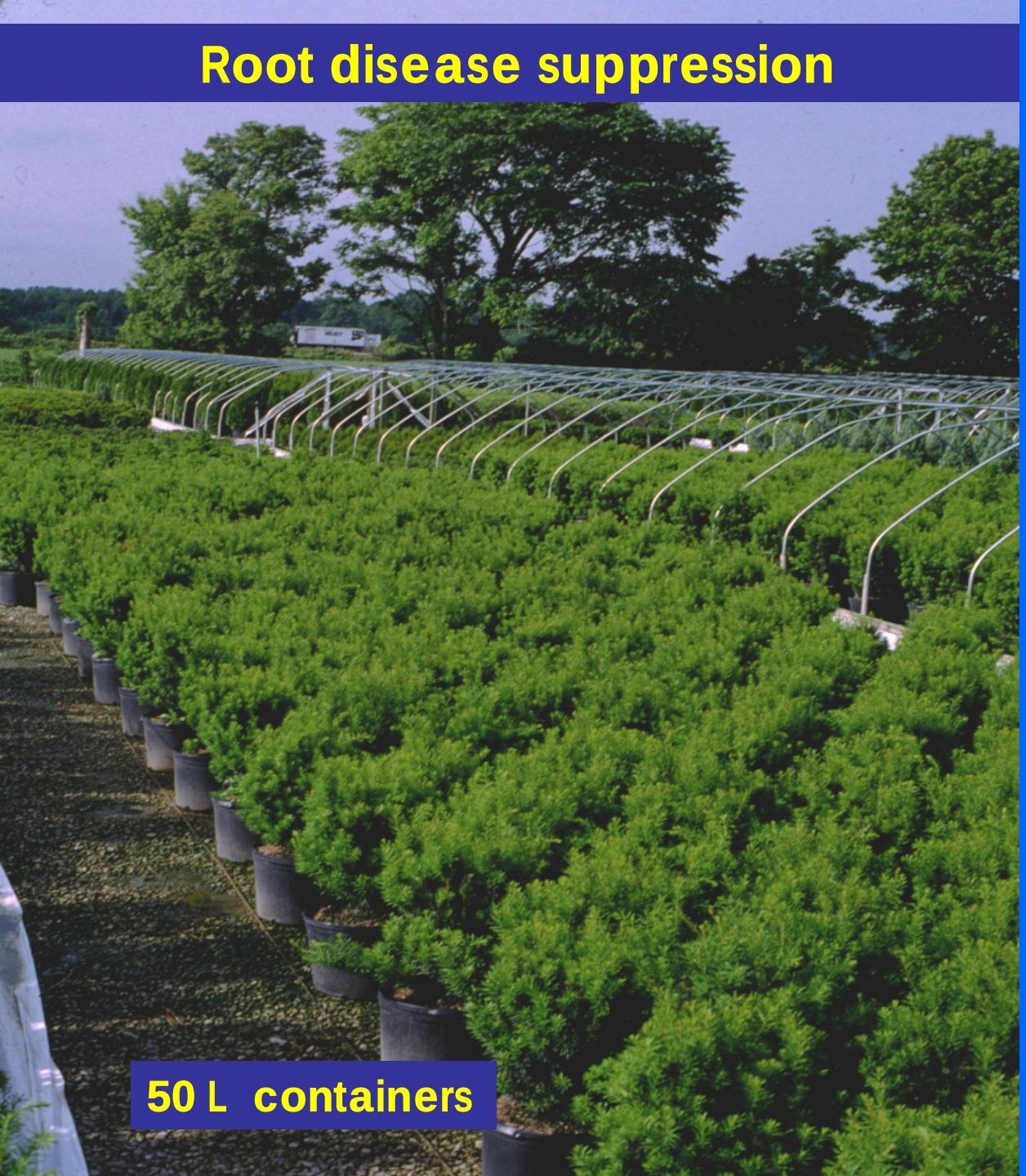
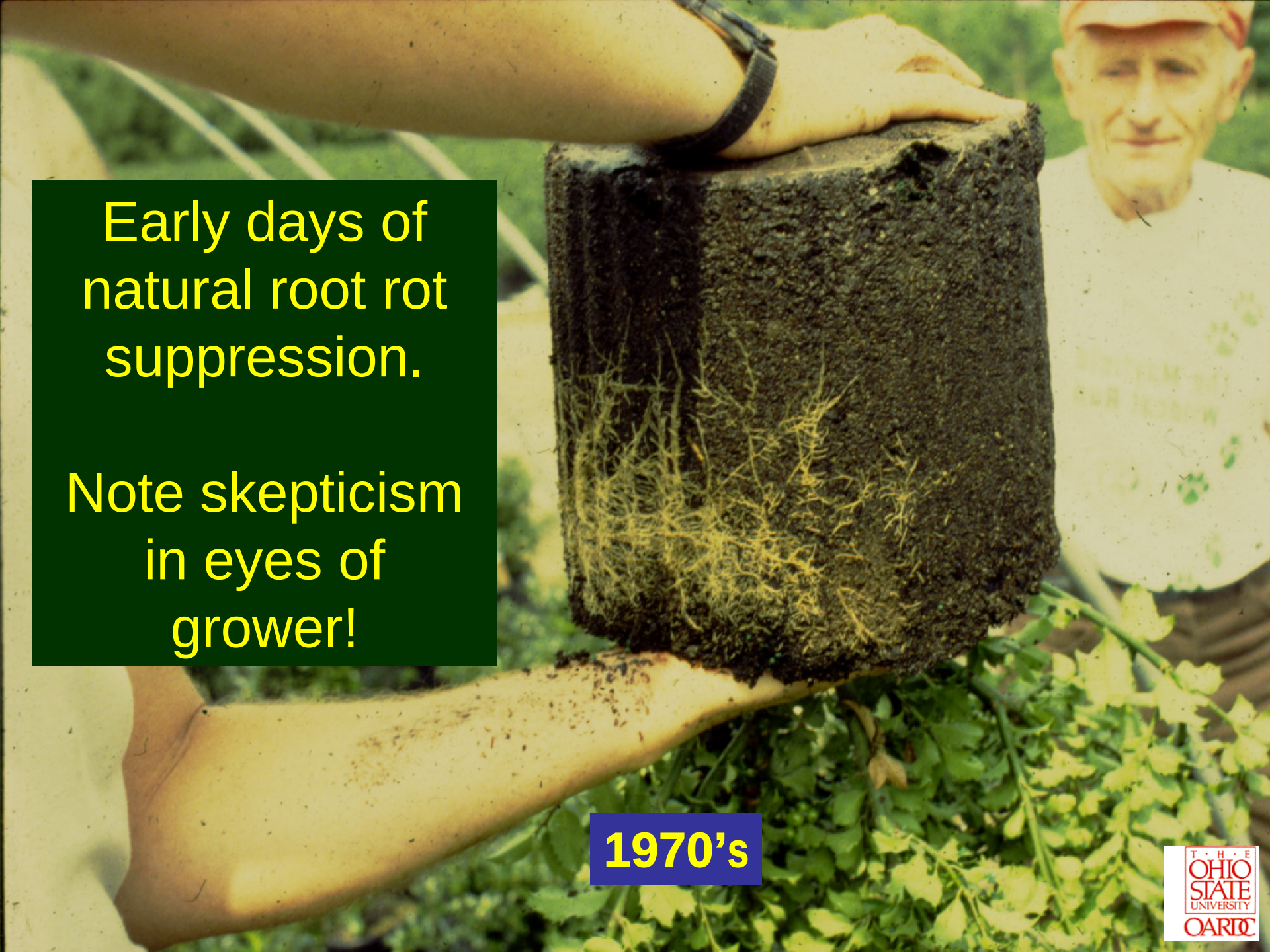
Root disease suppression



Seven-yr-old Taxus crop transplanted at 1-1.5 yr intervals to sustain natural suppression of root rot. Fungicides are not used even though Taxus roots are highly susceptible to *Phytophthora.*


Early days of natural root rot suppression.
Note skepticism in eyes of grower!
1970's
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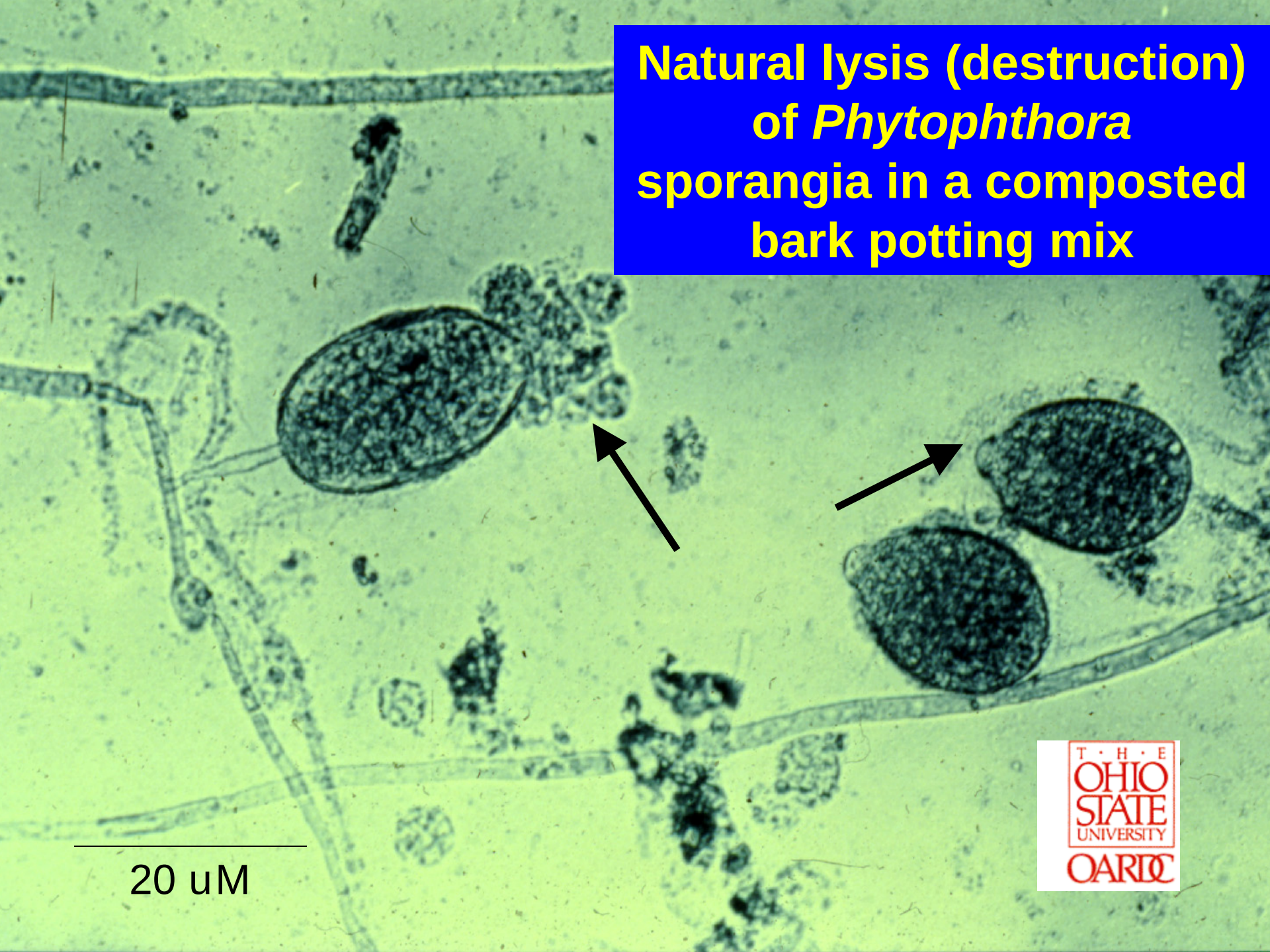
Natural lysis (destruction) of *Phytophthora* sporangia in a composted bark potting mix
20 uM
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Fate of beneficial microrganisms during composting and curing

- Composts produced on forest litter have the greatest diversity of microorganisms and the most broad spectrum disease suppressive effects against root diseases.
- Most composting sites do not offer this diversity because curing piles are too large with temperatures too high for beneficial microorganisms to survive.
- Long term curing eventually allows many important organisms to colonize composts and provide control of root diseases but this is not practical for most commercial operations.
- Inoculation of composts with biocontrol agents bring control to this process, particularly for systemic control of diseases of above ground plant parts.

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B) Suppression of Animal Diseases with Composts: Examples

- **Poultry**: Practiced since 1959 for broilers by composting sawdust-bedded manure between flocks. Reduces death rates over time through 4-5 production cycles.

- **Dairy Cows**: Recycled bedding sand and deep sawdust systems suppress mastitis by reducing coliform populations in bedding and on teats. Practiced widely since 1998.

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Bedding Options

- Mattress coved by sawdust results in high incidence of mastitis.

- Coliforms utilize glucose released from cellulose!!

Sand Bedding: Benefits

- Comfort ?
- Health
  - Fewer swollen hocks/Fewer knee injuries
  - No differences in SCC
  - Mastitis reduction
- Environmental Hygiene
  - Food Safety
    - Less *E. coli* O157

Disadvantage: high bulk density

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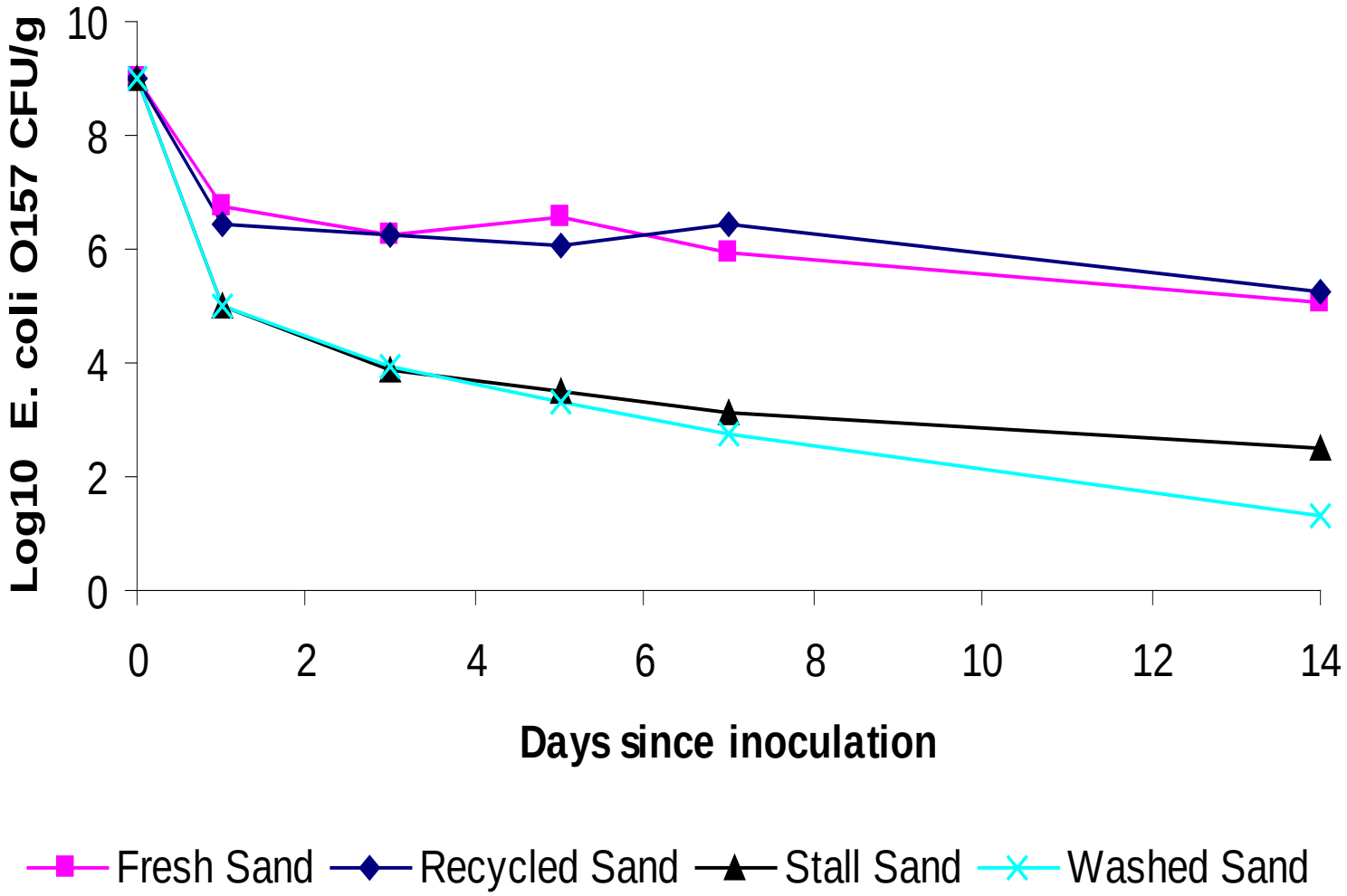
Survival of *E. coli* O157 in sand bedding



LeJeune et al., 2004,unpublished info.

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Environmental mastitis / bedding pathogen inoculum interactions

- Mastitis incidence relates directly to pathogen population on teat of dairy cow
- Rate of clinical mastitis relates directly to number of mastitis-causing organisms in bedding
- Population of Coliforms in bedding should be < 10^6CFU/g

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Composting Bedded Pack

- New technology that results in suppression of mastitis.

- Requires specific barn design
  - Feed alley
  - Bedded pack
  - Wall

Composting Bedded Pack

- Wood shavings or sawdust added at 3-4 week intervals
- Stirred at least twice daily
- Compost under cows reaches high temperatures (130^{o}F)

Western US Dairy Composts for Mastitis Suppression

- Dairy farms in CA, WA, ID which recycle manure after composting as bedding have lower somatic cell counts and less mastitis which suggests that this approach also lowers disease.

- High temps (> 160 F) and fires must be avoided during composting to avoid the destruction of the food base for beneficial microorganisms.

- At least once per year, all manure must be removed to avoid the accumulation of salts, heavy metals, etc.

How do composts suppress disease?

- Composts support beneficial microorganisms while competition prevails
- These organisms produce antibiotics and enzymes that suppress or kill plant pathogens.
- The net result is natural root rot suppression and less disease…..but many factors must be controlled to obtain consistent effects.
- Pyrolyzed, high in salinity composts are not effective!

C) New Technologies

Systemic induced resistance to foliar diseases (ISR)

- **Less than 2% of all types and batches of composts naturally induce ISR.**
- **Specific *Bacillus* strains and *Trichoderma* isolates are the most ISR-active microorganisms.**
- **Controlled inoculation with ISR-active biocontrol agents will soon be an EPA registered concept.**

Zhang et al, 1998, Phytopathology 88: 450- 455.
Krause et al, 2003, Phytopathology 93:1292-1300.

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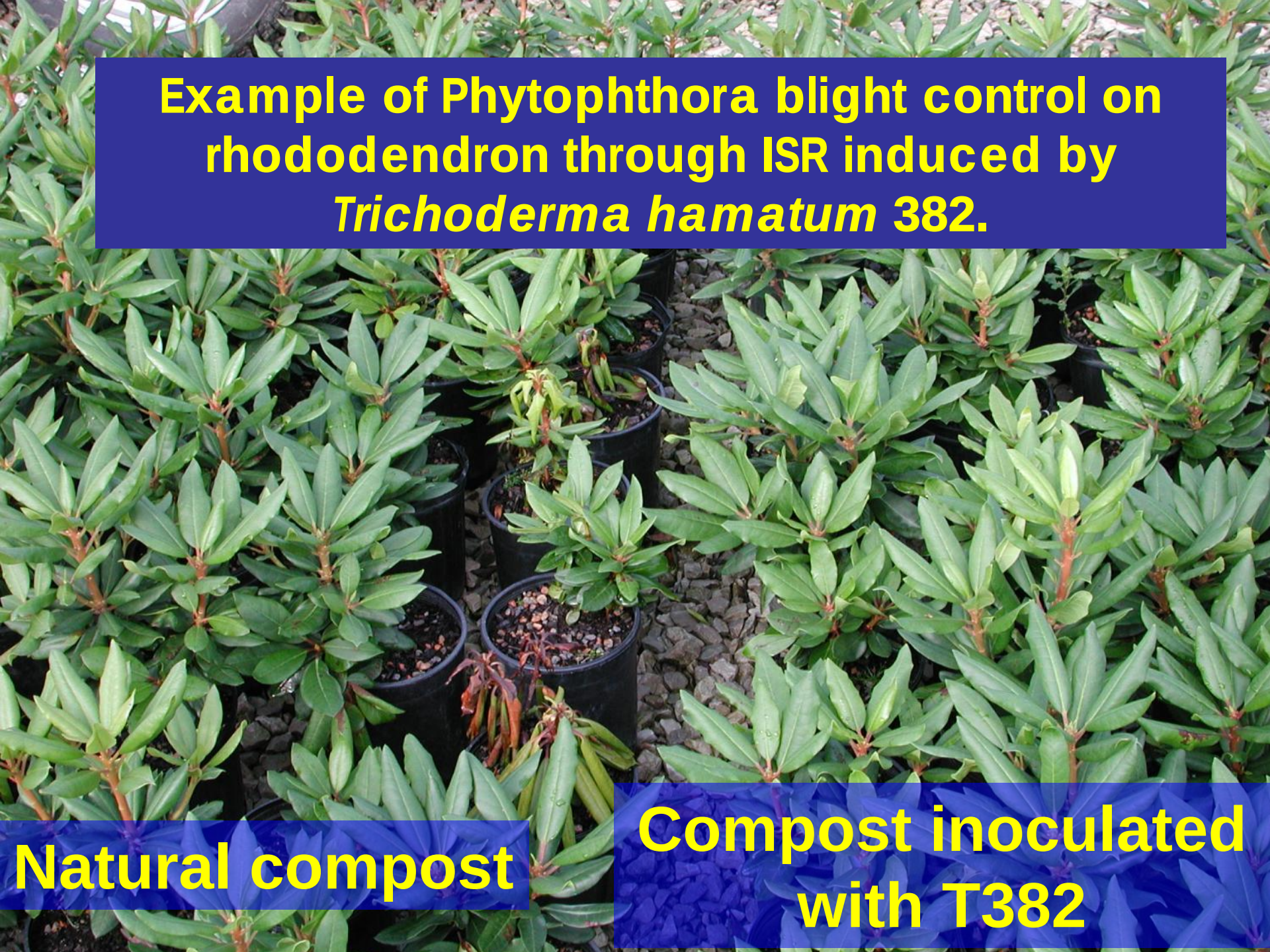
Example of Phytophthora blight control on rhododendron through ISR induced by *Trichoderma hamatum* 382.
Natural compost
Compost inoculated with T382

Systemic Disease Resistance Mechanism

- Jasmonic acid/ethylene pathways are involved (Pieterse et al., 2003; Soresh et al., 2005).

- Extensin proteins and PR 5 seem to play a role in ISR mechanism induced by *Trichoderma* (Alfano et al., 2007).

Questions

Do cows have an equivalent ISR mehanism?

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