Sanitation for nurseries

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Why is Sanitation Important?

- Maintaining a clean nursery operation prevents unwanted pests and diseases from entering the nursery

- Sanitation should be considered one of the most important factors in a nursery operation

Sources of inoculum

- People and their vehicles
- Plants
- Dirty pots, tools, and equipment
- Soil
- Water
- Plant debris and cull piles
- Weeds, algae, and associated insects (shoreflies and fungus gnats)

People

- Employee training
- Visitor sign-in at office
- Footbaths at entry to clean areas

1. dirty boots

2. rinsed with water

3. disinfected

Source: ILVO

ILVO

UNIVERSITEIT GENT

Remove soil and mud from shoes before using disinfectant footbaths.

1. What kind of access do customers and visitors have to your nursery?

Visitors sign in at office
Only nursery vehicles allowed on property
Loading dock area for deliveries
Public access to retail area, employees only in wholesale and production areas
Full access by customers and their vehicles

Equipment

- Vehicles
- Carts and wheelbarrows
- Hoses
- Tools

Delivery vehicles

- Delivery vehicles should be directed to a designated area upon arrival
- Do not allow drivers to sweep out their vehicles on your property
  - Send them away to clean the vehicle before returning
- **You do not know where they have been!**


Keep vehicles on designated roadways
Avoid hitting any puddles in the roadway to reduce splash on surrounding plant material

Plants

- Incoming plants should be examined on arrival
- Returned plants are potential carriers of disease

Proper plant spacing will reduce stress and disease spread

- Better airflow to reduce humidity
- Plant to plant contact is reduced

Spread of Pr within a nursery

- Very moist conditions needed for infection & disease expression
- Direct contact = very important for plant-to-plant spread
- Aerial dispersal = very unlikely. Spore loads too small?
- Spread via water film and splash dispersal = most likely
- Tipping over in zoospore-containing water film = infection
- -> production nursery: most likely spread via water films

Within-Field Spread of *Phytophthora ramorum* on Rhododendron in Nursery Settings
Kurt Heungens, Isabelle De Dobbelaere, Bjorn Gehesquière, Annelies Vercauteren, and Martine Maes. In Frankel, Susan J.; Kliejunas, John T.; Palmieri, Katharine M. 2010. Proceedings of the Sudden Oak Death Fourth Science Symposium. Gen. Tech. Rep. PSW-GTR-229. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 378 p.

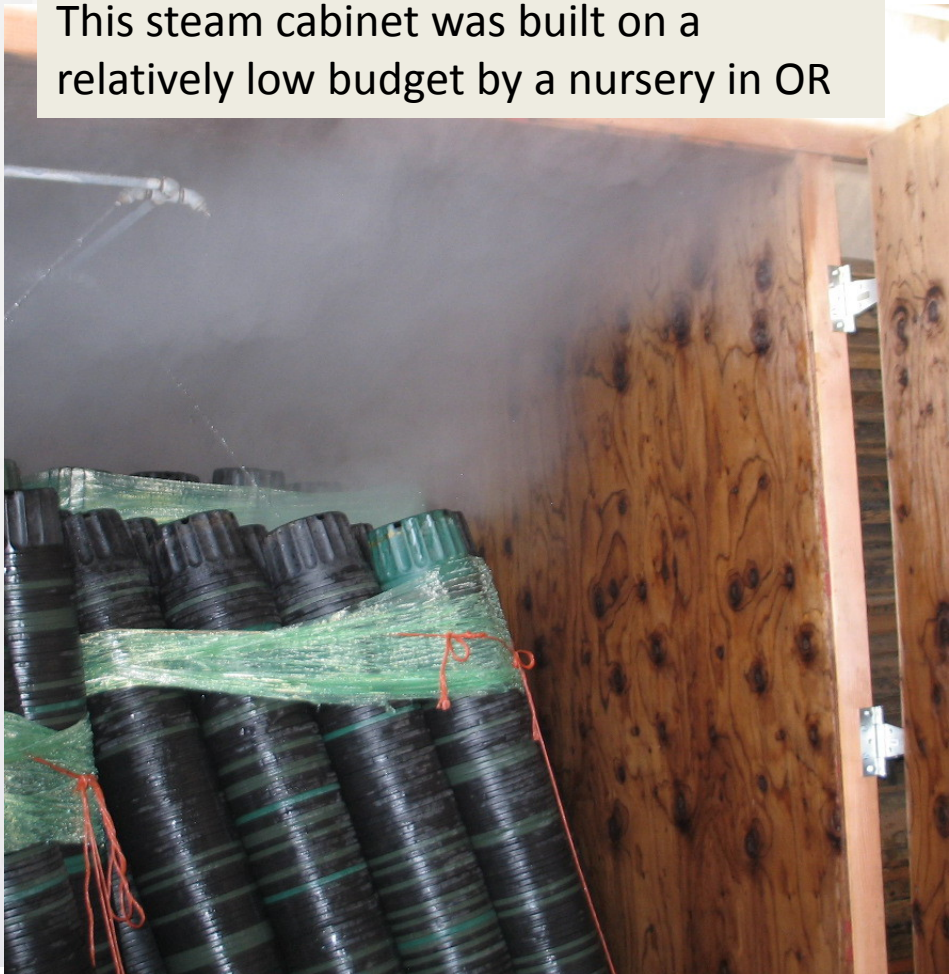

Keep plant debris from accumulating

Pots

- Soil and plant material clinging to used pots and trays are a source of pests, diseases, and weeds
- Pots can be treated with disinfectant, steaming, or hot water dip

Hot water dip tank for 4” pots

This steam cabinet was built on a relatively low budget by a nursery in OR



Disinfectants for tools, pots, and other hard surfaces

- Chlorine bleach – corrosive, do not use on metal tools
- Quaternary ammonium compounds
- Hydrogen peroxide

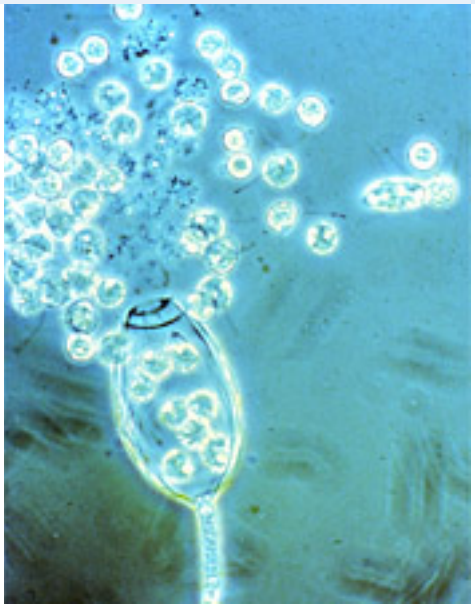
- Wash organic debris off with water then soak in disinfectant for 10-15 minutes

2. How do you deal with used pots and/or trays at your nursery?

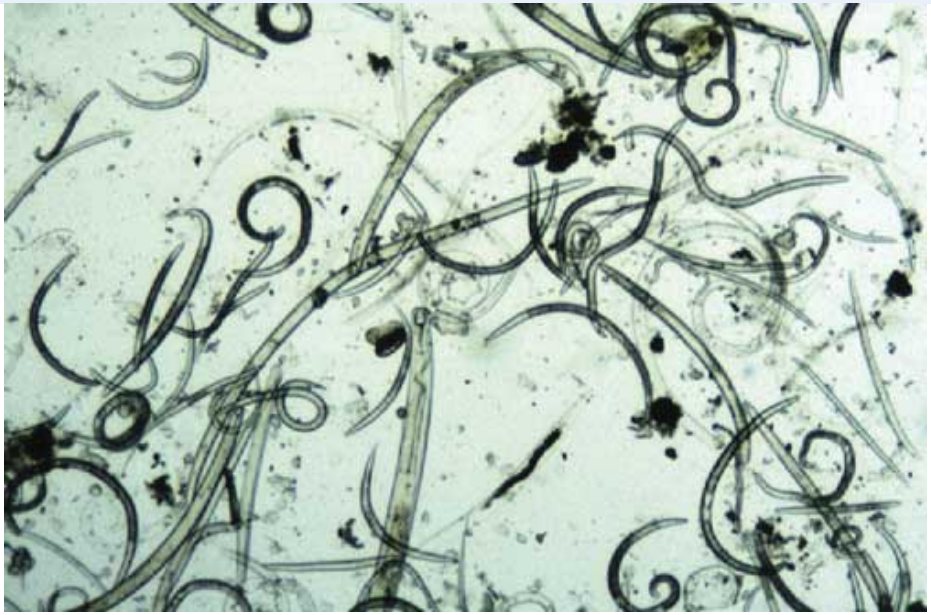
Wash and sanitize prior to re-use
Discard used pots and trays and buy new ones
We re-use dirty pots and trays

Substrate

Diseases that thrive in wet soils



Phytophthora (F.W. Schwenk, Kansas State University)



Plant-parasitic and non-parasitic nematodes recovered from soil by sieving. (Greg Tylka)

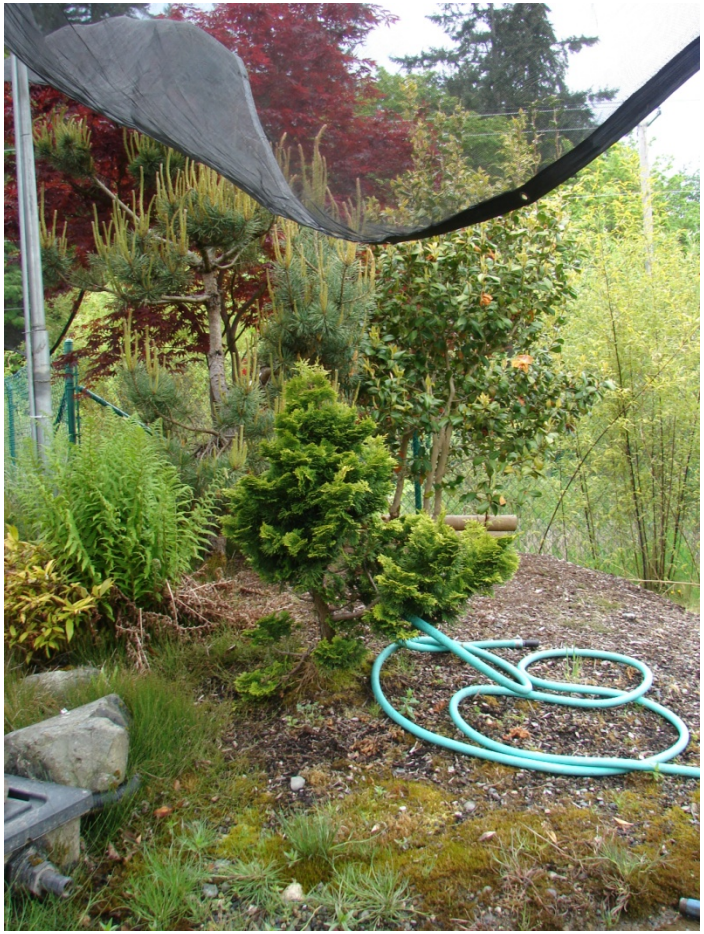
- Oomycetes or “water molds”
- Certain fungi
- Bacteria
- Nematodes

Many pathogens produce resistant "resting spores" that can survive in soil.

Chlamydospores in infected foliage are a source of Pr inoculum in soil

The soil phase of *P. ramorum*

- Pr can survive for at least 8 - 11 months in soil or potting media
- Chlamydospores germinate and form sporangia near roots
- Infected root tips seen covered with sporangia
- Pr was detected in root balls of potted Rhododendrons 2 years after purchase



Shishkoff, N. 2007. Persistence of *Phytophthora ramorum* in soil mix and roots of nursery ornamentals. Plant Dis. 91: 1245-1249

Vercauteren et al. 2012. Survival of P. ramorum in Rhododendron root balls and in rootless substrates. Plant Pathology doi:10.1111/j.1365-3059.2012.02627.x

Prevention BMPs for soil:

Cull piles are a breeding ground for diseases. Keep them separate and downhill from production areas.

Soil and media piles should be covered to prevent weeds and pathogens

Media piles should be on an impervious surface with good drainage to prevent contamination, and uphill from production areas.

More prevention BMPs for soil

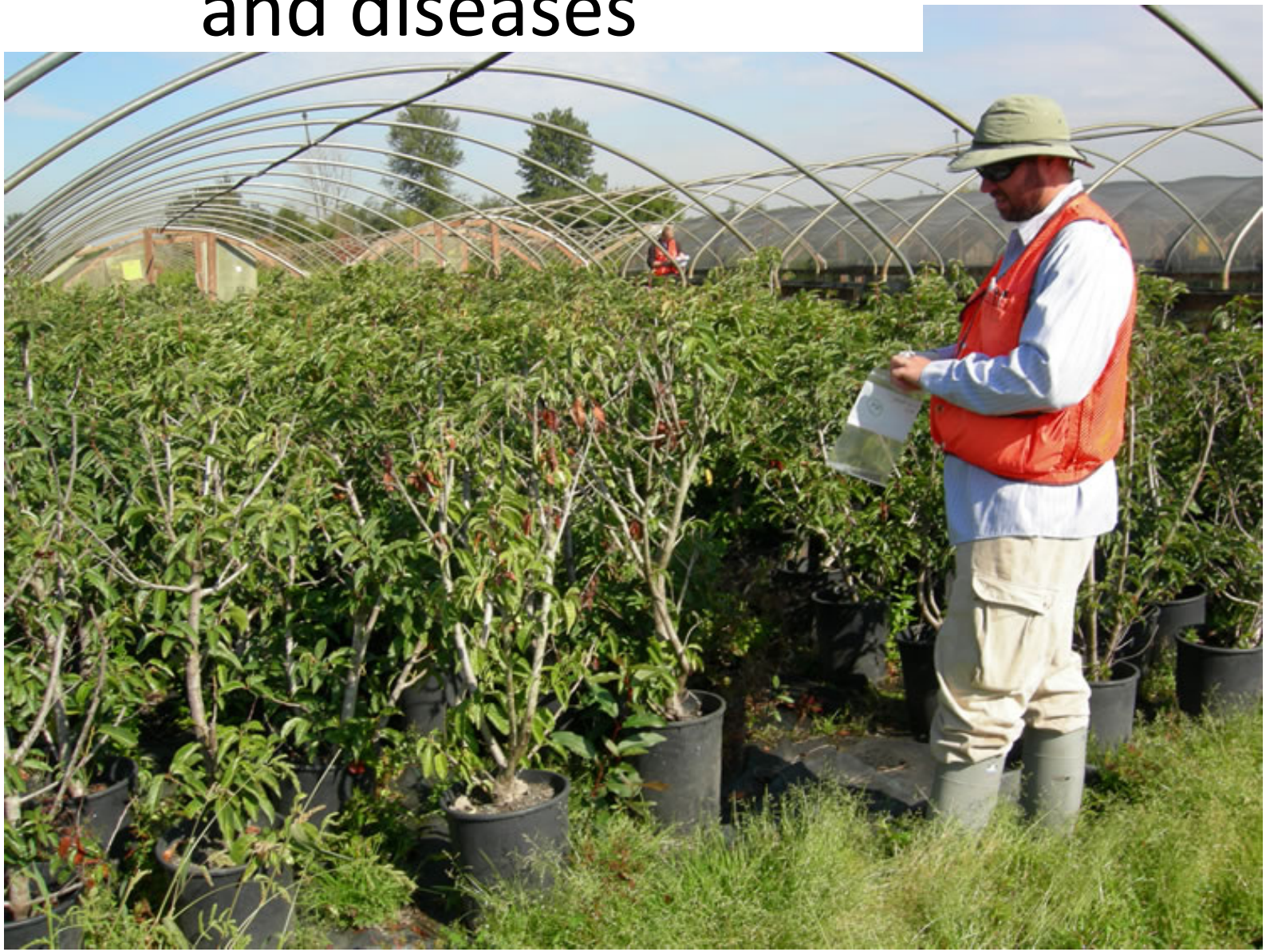
Use pallets or benches underneath pots

Gravel layer of 4-6” will provide drainage and separate plants from soil surface

3. What surface are container plants placed on at your nursery?

Weed mat
Gravel
Bare soil
Pallets
Benches
Other

Weeds are a source of pests and diseases



Algae

Good drainage is important

Fungus gnats

Found in wet soil environments

Feed on algae and fungi.

Larvae feed on plant roots.

Adults can spread plant diseases by moving from plant to plant.

Whitney Cranshaw, Colorado State University, Bugwood.org

Animal vectors for *Phytophthora*

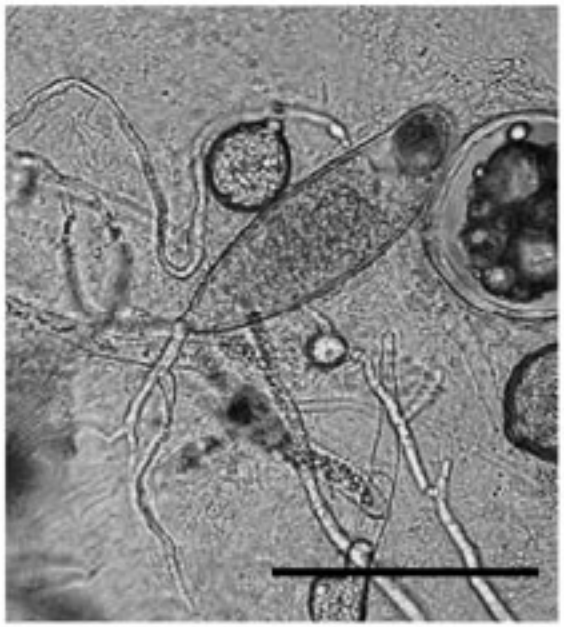


Fig. 5. Germinated sporangia of Phytophthora ramorum in snail frass. Bar = 55 µm.

Snails – chlamydospores and sporangia

Shore fly larvae – chlamydospores
Shore fly adults – none

Fungus gnat larvae – chlamydospores
Fungus gnat adults - none

Hyder, N., Coffey, M. D., and Stanghellini, M. E. 2009. Viability of oomycete propagules following ingestion and excretion by fungus gnats, shore flies, and snails. Plant Dis. 93:720-726.

You might have contaminated soil if

- In-ground plants are symptomatic in an area
- Batches of potted plants from a media pile are symptomatic
- There is standing water indicating a drainage problem
- The soil tests positive for *Phytophthora*

Photo: Jay W. Pscheidt.

Prevent re-contamination of treated soil

Before treating the soil, ensure that the problem doesn't happen again by

- Relocating any nearby cull piles
- Place media on impervious surface with good drainage
- Improve drainage to route water away from plants

Treatments for contaminated soil

Soil amendments/
Biocontrol

Solarization

Steam

Fumigation

Some soil organisms are beneficial

Cellulase producing fungi

Bacteria and actinomycetes produce antibiotics

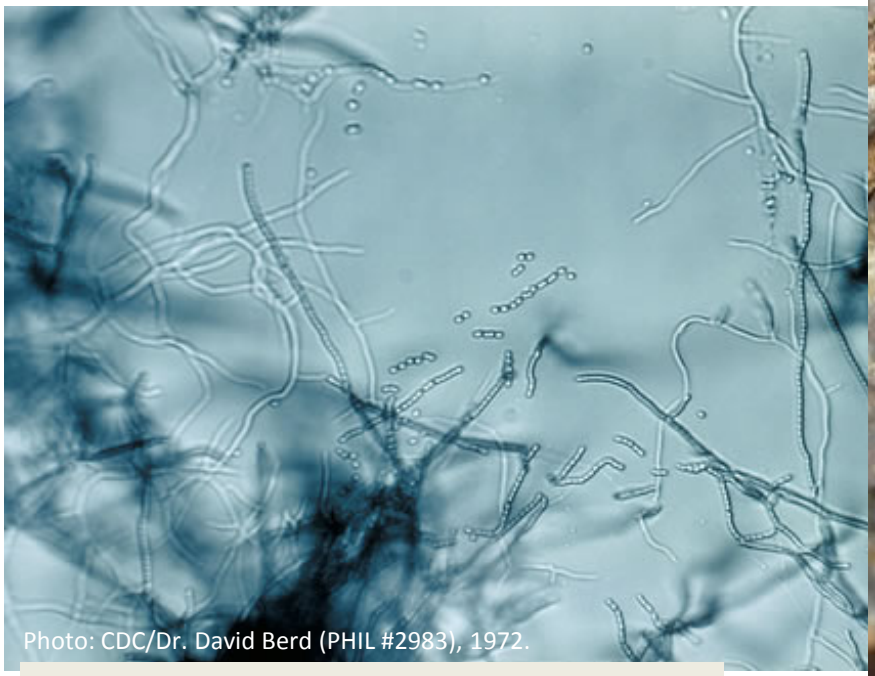


Photo: CDC/Dr. David Berd (PHIL #2983), 1972.

Streptomyces spp. are common in soil and produce antibiotics

Several species of *Trichoderma* are antagonistic to *Phytophthora* spp.

Organic soil treatments

Mulches, composts, and bark chips contain antagonistic bacteria and fungi

Photo: Wilson's Garden Center, Utica, OH

Phytophthora + Trichoderma

Normal Pr chlamydospore

Pr chlamydospore parasitized by Trichoderma

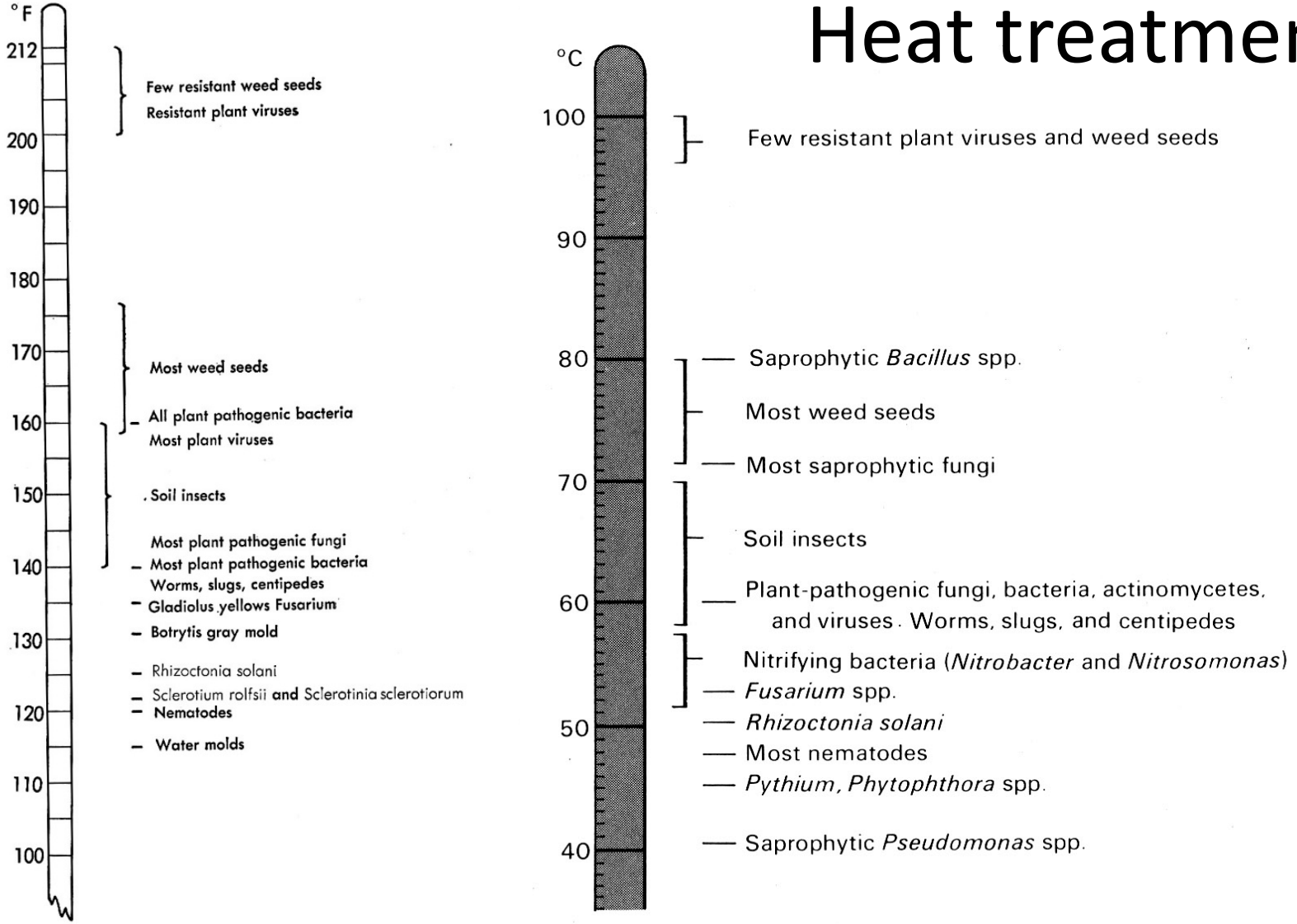
Chemical fumigation

- For large areas of soil
- Kills beneficial organisms

- Dazomet – granular formulation
- Chloropicrin
- Metam sodium – can be worked into soil or applied through irrigation

Check label for approved crops and application methods before use

Heat treatment

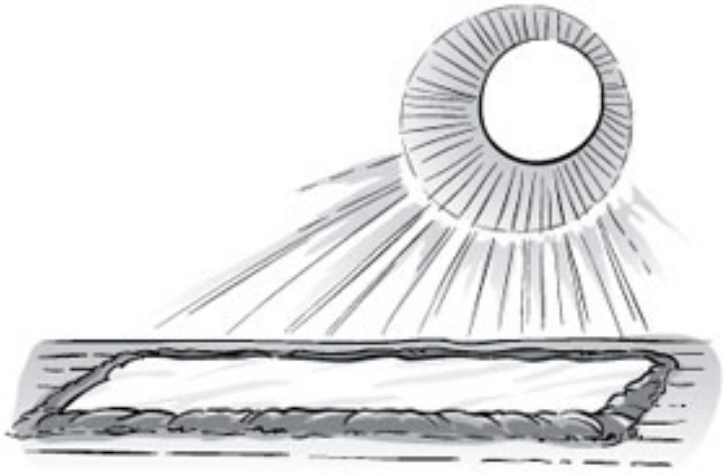


Temperatures necessary to kill various groups of soil organisms

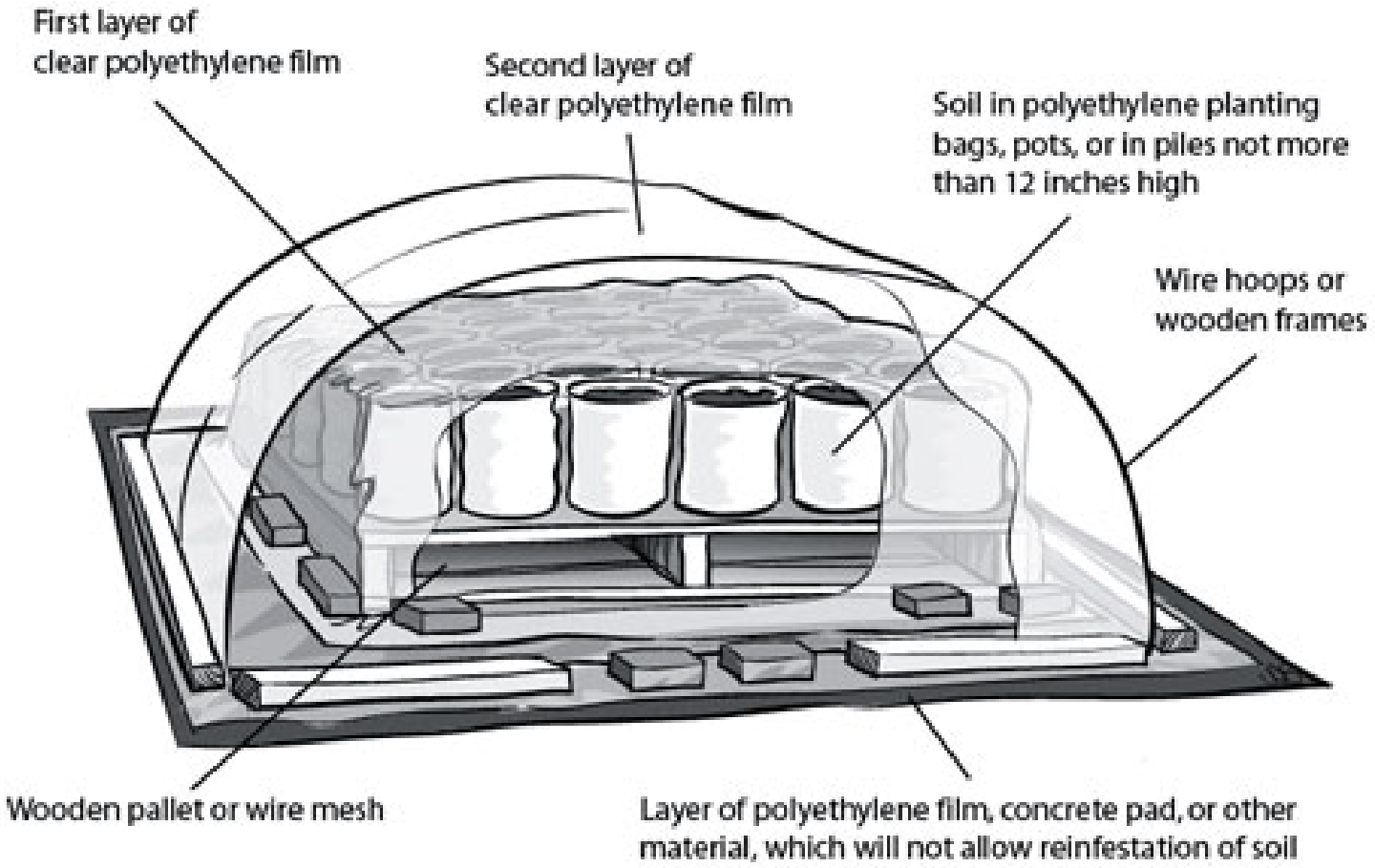
Solarization

Heats top layer of soil to kill pests and pathogens.

Need 4-6 weeks of clear skies, long days, high temperatures.



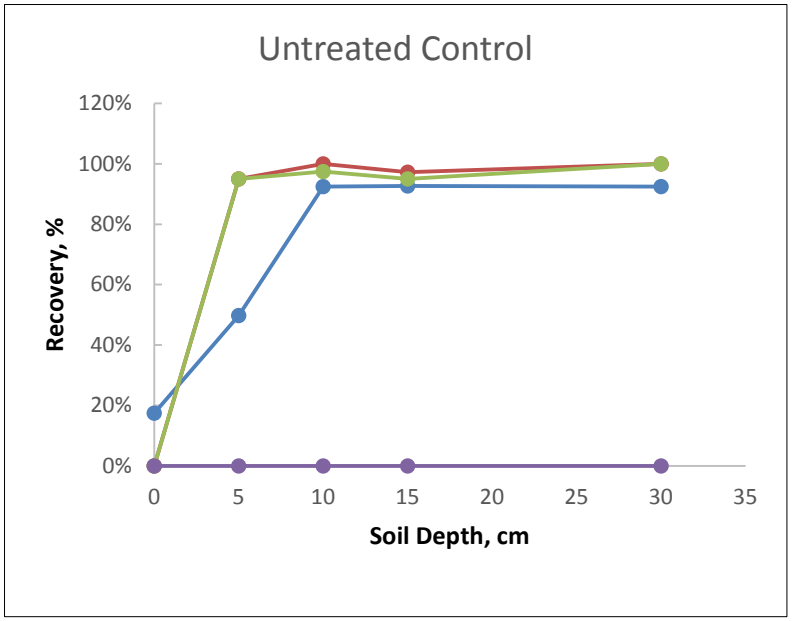
Pots and media can also be solarized

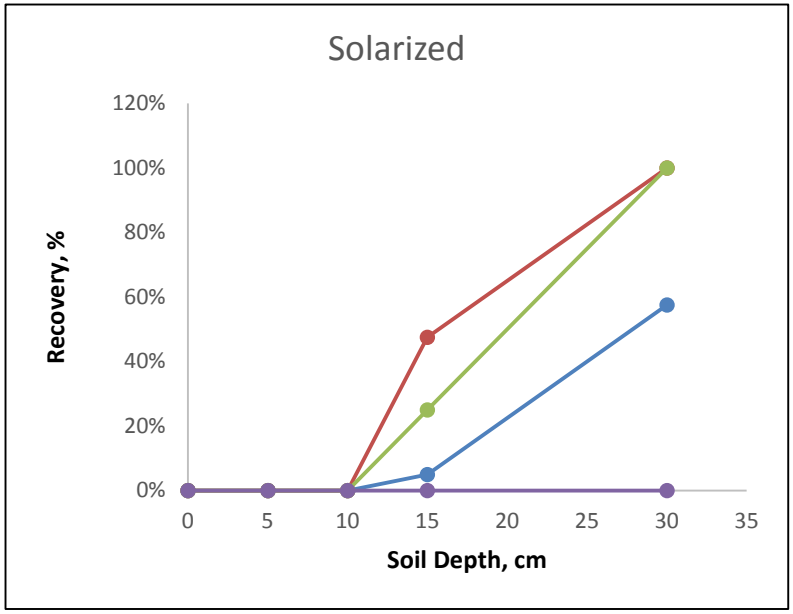


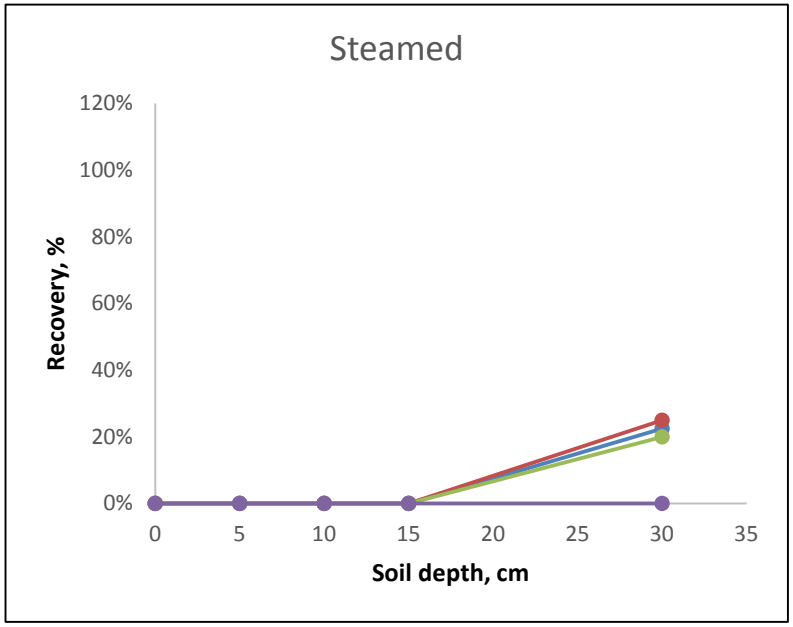
Pest Notes: Soil Solarization for Gardens & Landscapes Management. UC ANR Publication 74145

Soil solarization/steaming experiment at WSU Puyallup, July-August 2014

Recovery of *Phytophthora* spp. from various soil treatments – preliminary data







P. plurivora
P. gonapodyides
P. taxon PgChlamydo
Noninoculated control

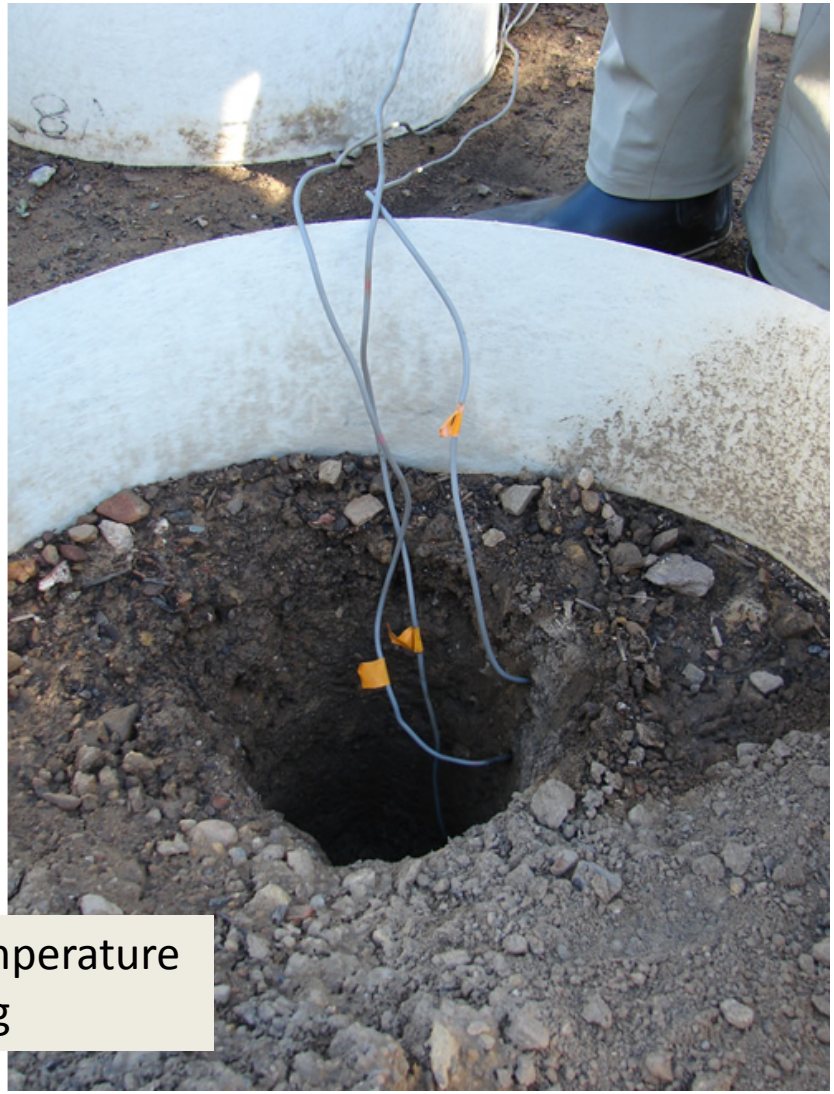
OSU-WSU Soil disinfestation study
Puyallup, WA 7/22/14-8/19/14

Steam treatment of contaminated soil

Soil should be at 50 C (125 F) for 50 minutes to kill pathogens

Moisture content and soil composition/bulk density will affect time needed to reach target temperature

Most of the inoculum will be at <5 cm, but may percolate further in looser soils



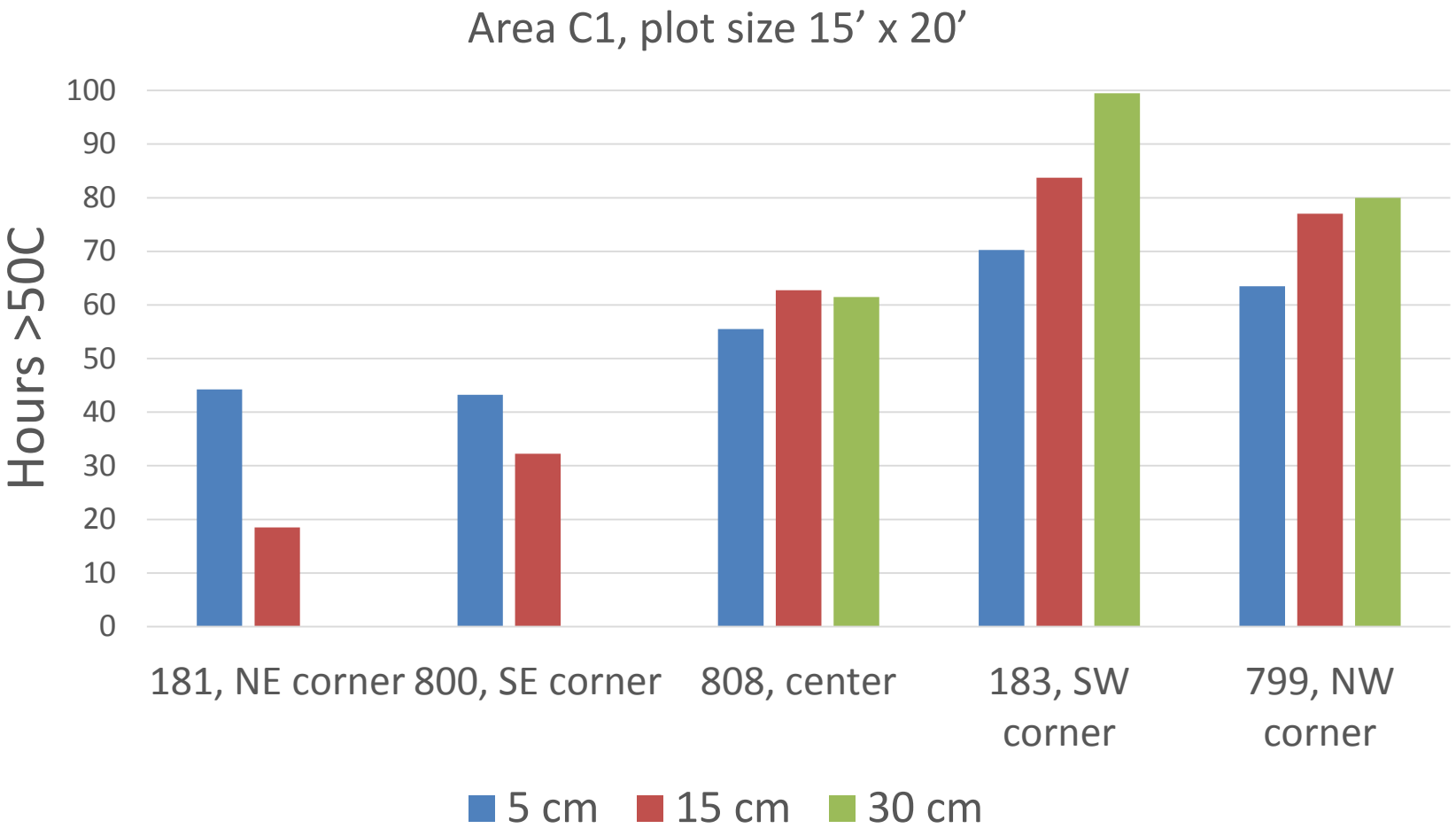
Data is collected on soil temperature at 3 depths during steaming

Sheet steaming and steam boiler. Photo: H.D. Siefert

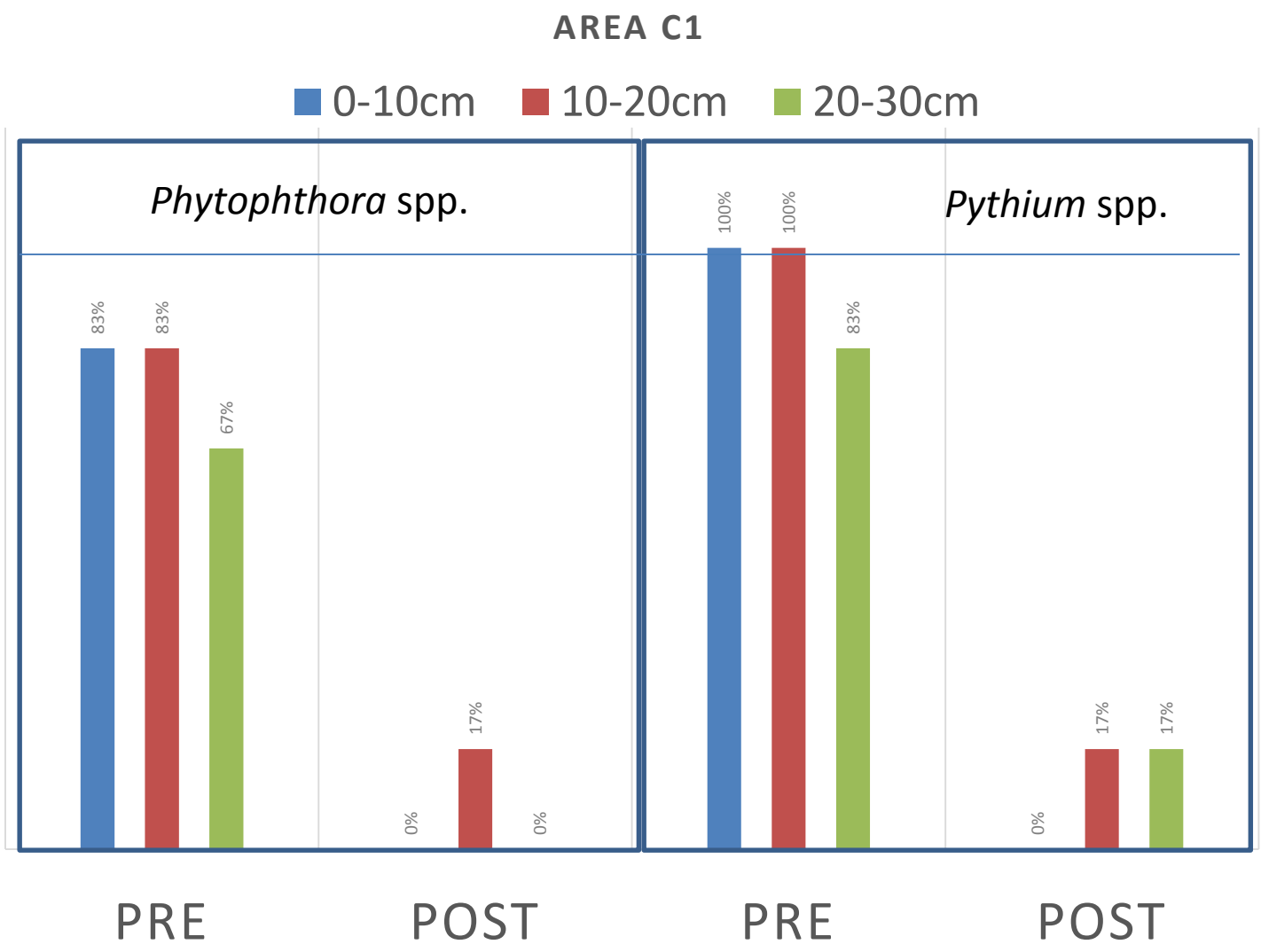
Robot soil steamer

Information on this and other methods can be found at
http://www.marten-barel-consultancy.com/steaming-methods/

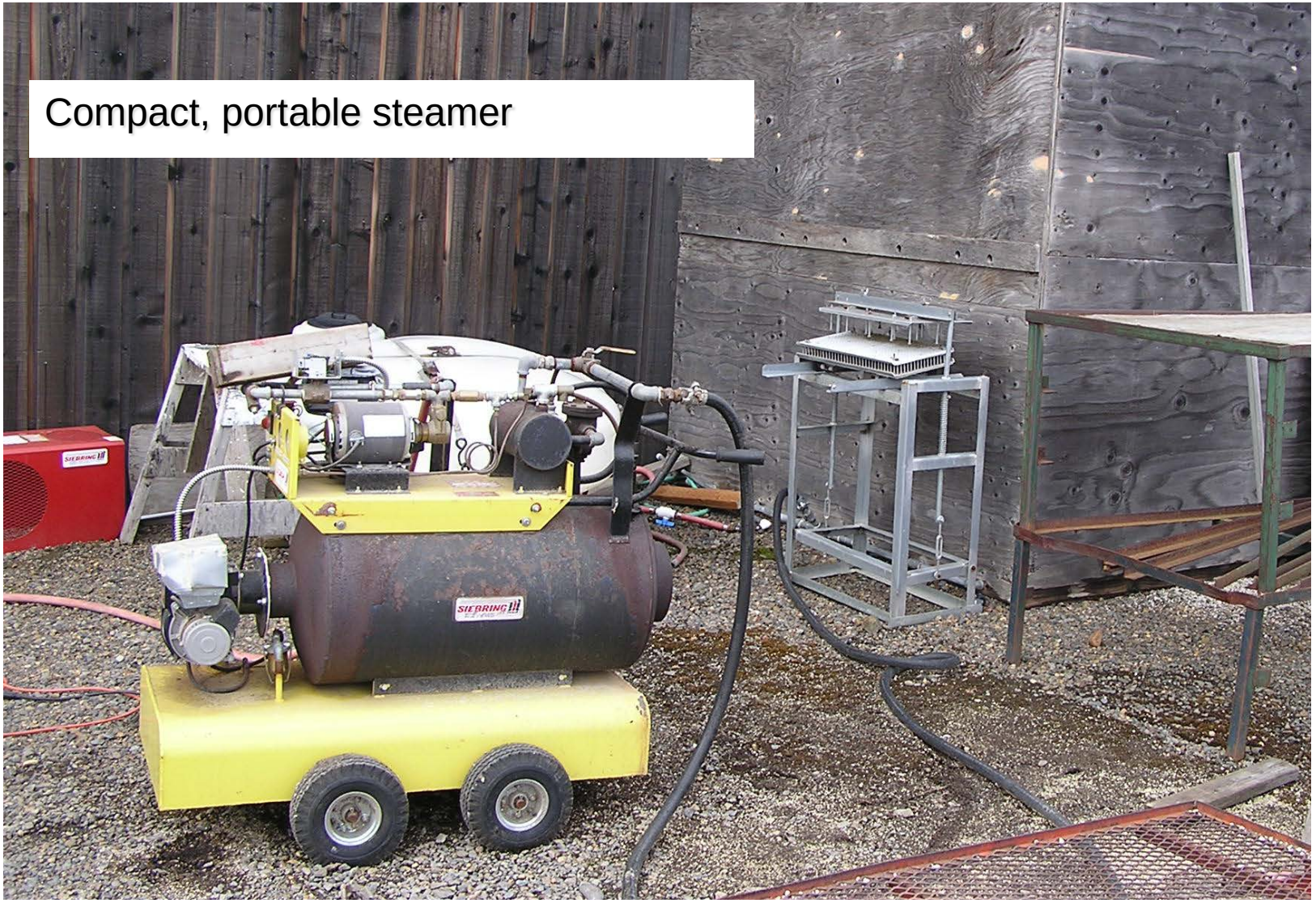
Steam treatment of *P. ramorum* positive soil at a nursery



Survival

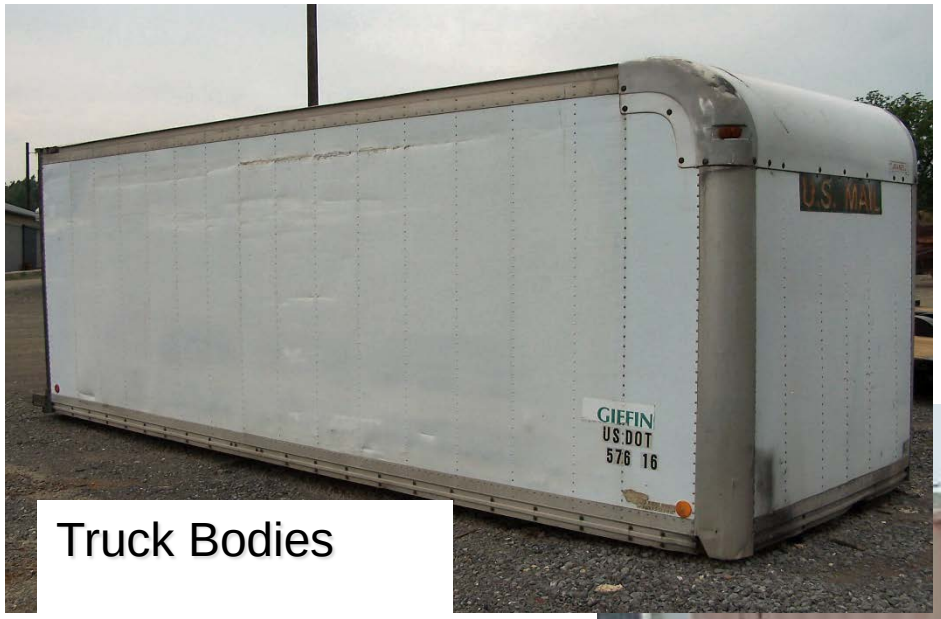

AREA C1
0-10cm
10-20cm
20-30cm
Phytophthora spp.
Pythium spp.
83%
83%
67%
0%
17%
0%
100%
100%
83%
0%
17%
17%
PRE
POST
PRE
POST

Steam Chamber for Pots




MAVERICK
76 C
86 C
MIN
SEC
°C/°F
S/S

Steam Chamber Construction



Truck Bodies

Ocean Containers

Siebring steam cabinet

stainless steel cabinet accommodates pallets of pots

4. Which of these methods do you use to treat soil and/or potting media at your nursery?

Steam
Solarization
Chemical fumigation
Biocontrol
None
N/A