

**Best Management Practices Workshop for Nurseries: Steam  
Sanitation and Disease Identification**

# Heat Treatment Techniques, Equipment, and Costs

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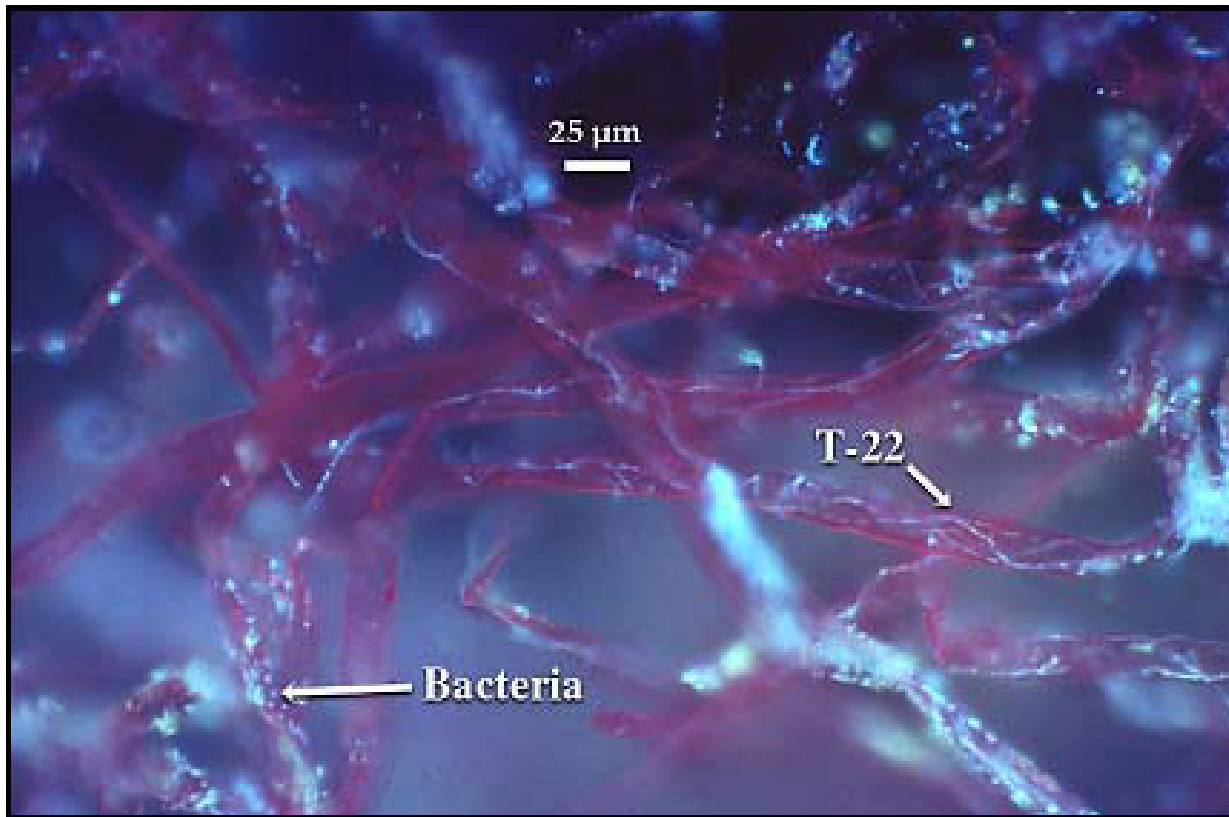
# Heat treatment of soil

Affected by

- Soil moisture
- Soil type
- Soil temperature



Post-treatment biocontrols may prevent disease from re-occurring in soil



Colonization of root hairs of corn by the highly rhizosphere competent strain of *T. harzianum* T22. Used with permission of the American Phytopathological Society (Harman. 2000. *Plant Disease* 84:377-393).

# Phytophthora + Trichoderma



Normal Pr chlamydospore



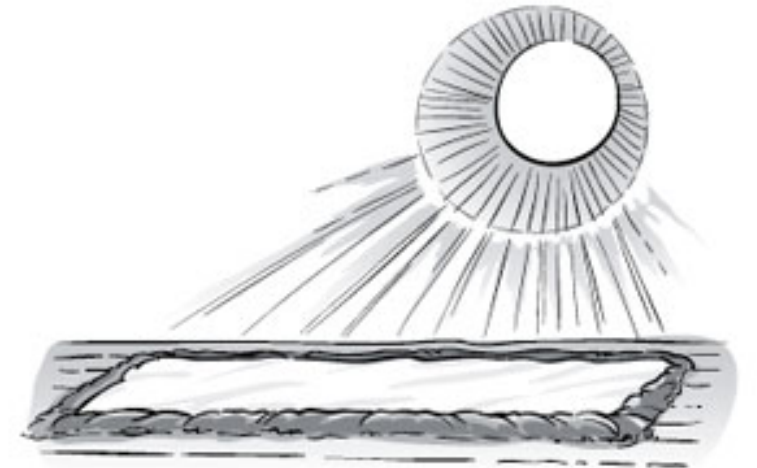
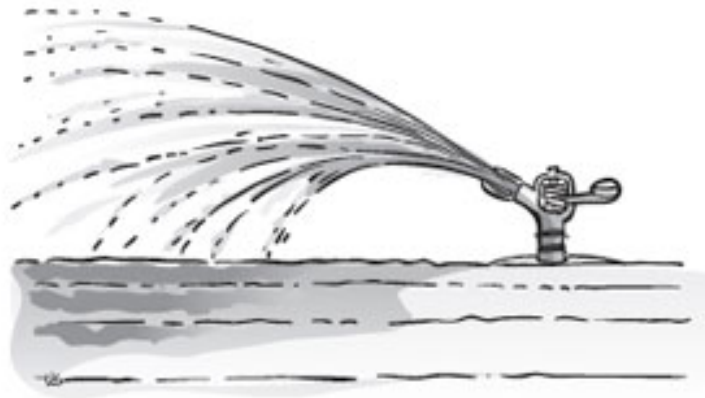
Pr chlamydospore parasitized by  
Trichoderma

Many Trichoderma spp. and other beneficial organisms can survive heating.

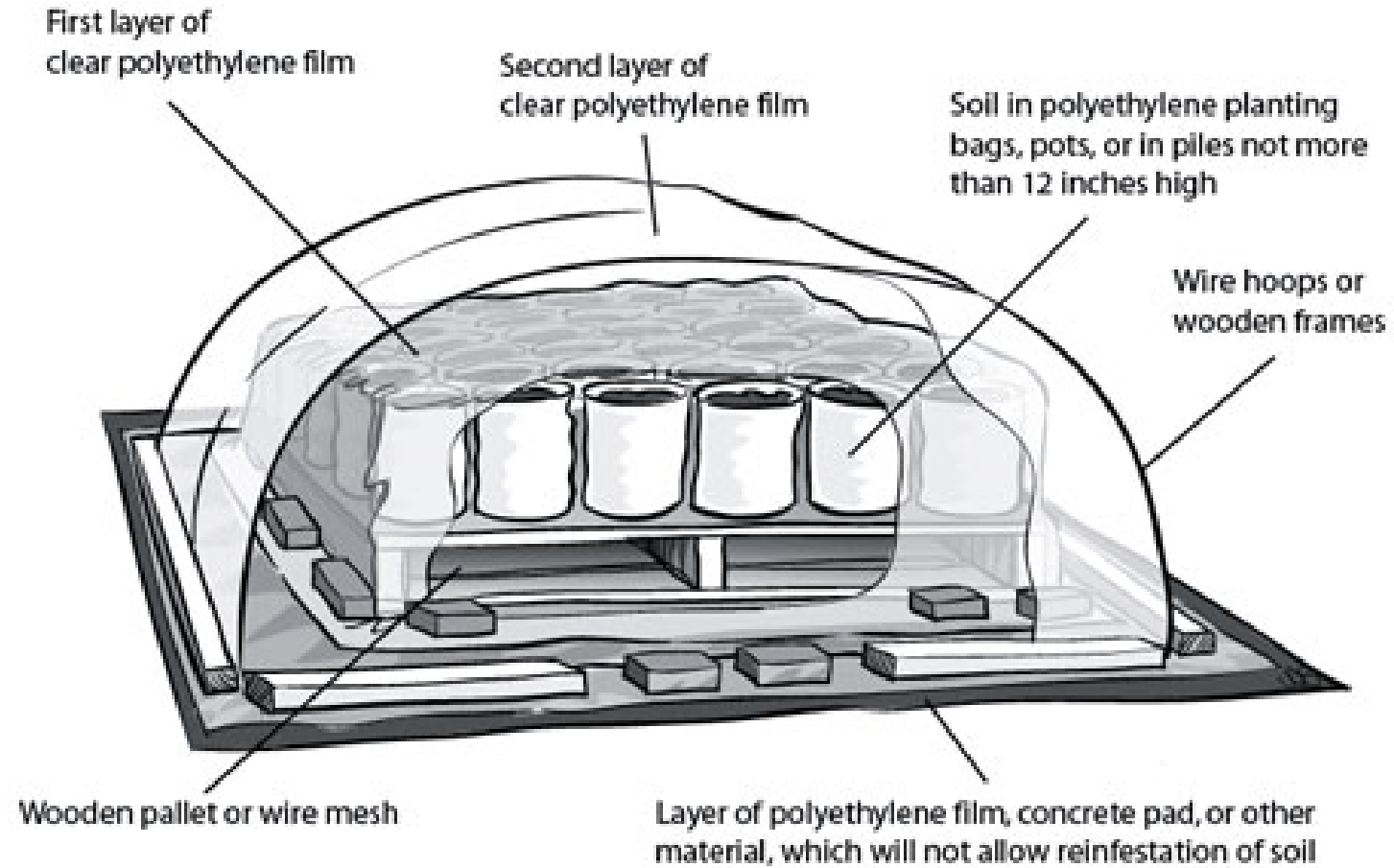
# Solarization

Heats top layer of soil to kill pests and pathogens.

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



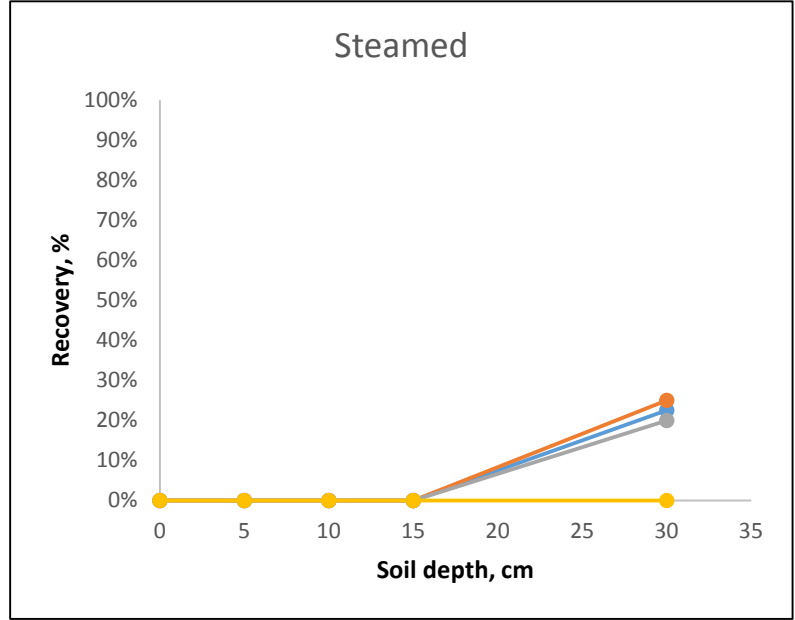
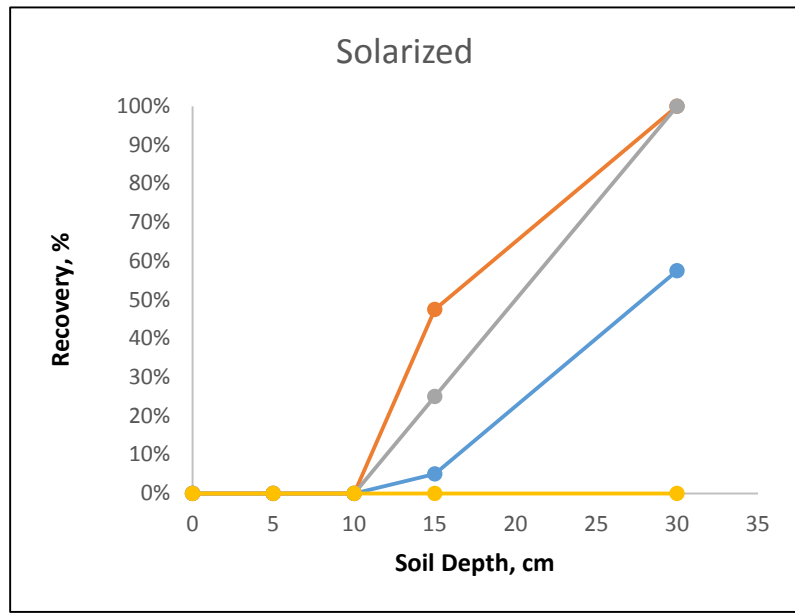
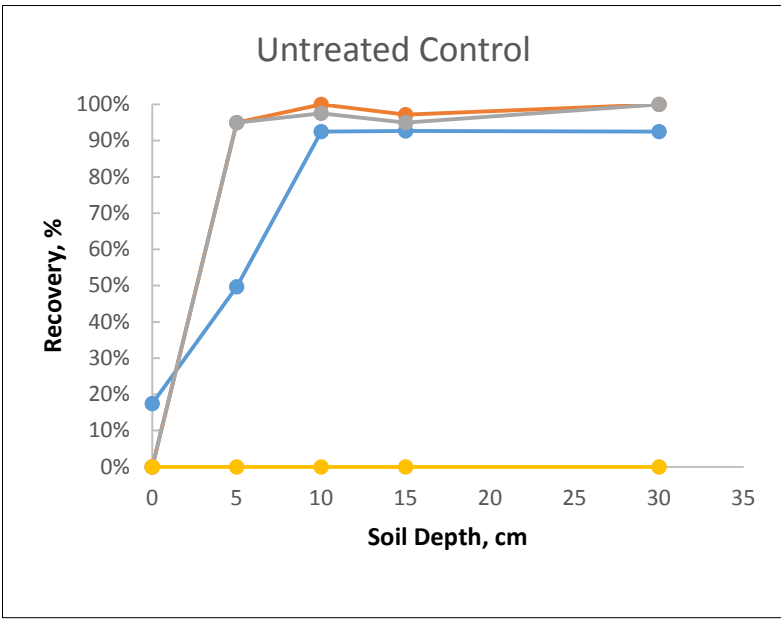
# Pots and media can also be solarized



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



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



Leaf discs infested with *Phytophthora* spp. were buried at 5 depths in each plot

- *P. plurivora*
- *P. gonapodyides*
- *P. chlamydospora*
- Noninoculated control

# Soil steaming to kill *Phytophthora*

< 50C for 30 minutes

15 – 30 cm depth



# Equipment

## Sioux Steam-Flo SF-20

Fuel: Oil (kerosene)

65 gal fuel tank

300 gal water tank

135 gal boiler

Steam output 690 lb/hr

Fuel use rate (5.65 gph listed #2 fuel oil) avg rate 5.5 gph using kerosene





# Robot soil steamers



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

# Soil auger

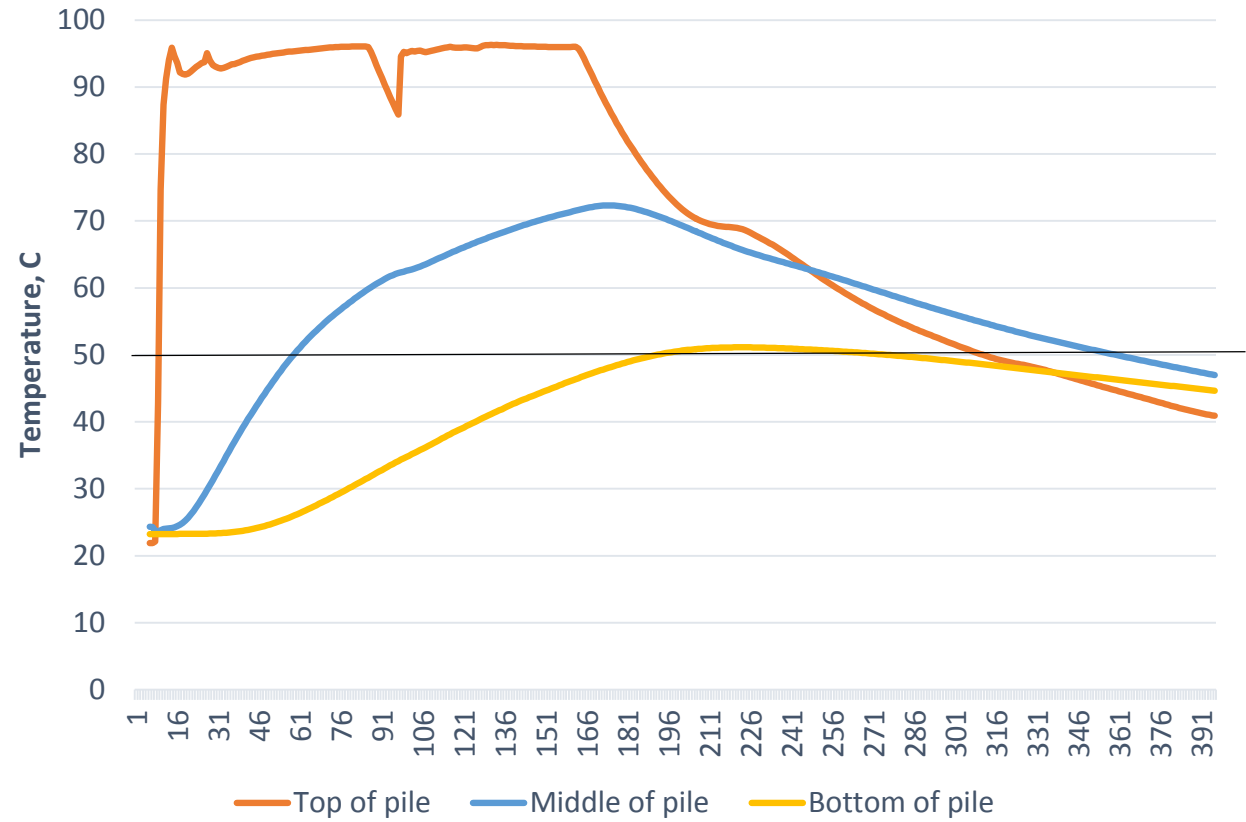


**Spot-treatment of tree planting sites in orchards with infested soil**

**Alternative to using fumigation**

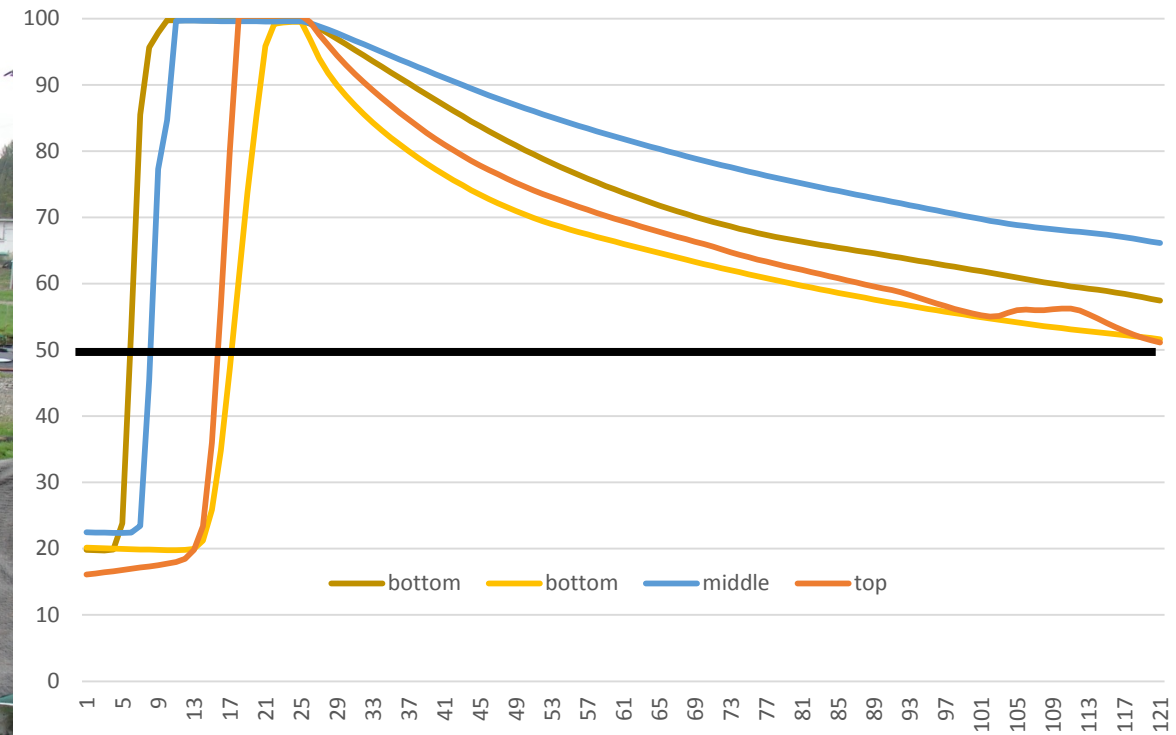
[http://www.plantsciences.ucdavis.edu/plantsciences\\_faculty/hanson/](http://www.plantsciences.ucdavis.edu/plantsciences_faculty/hanson/)

# Compost heated from top



Total steaming time: 38 hrs (2 19-hr days)

# Compost heated from bottom



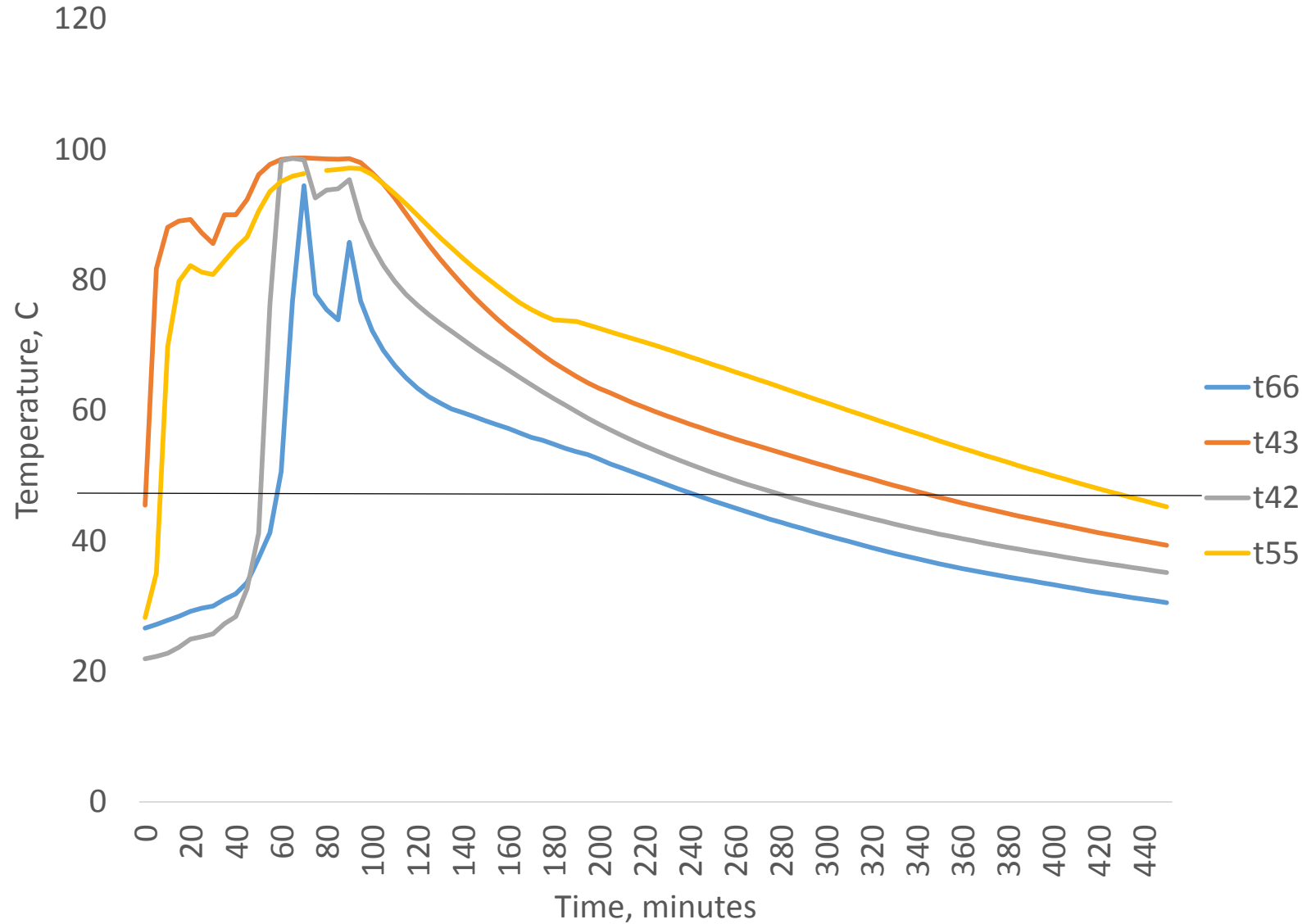
Total steaming time 5.7 hrs

# Pots

Residual soil or potting media in used pots is a source of infestation – weeds, pathogens, pests



# Pot Steaming 2, 8/4/2014



Top of area C1, former potting media site

Duration of steaming: 95 minutes

Maxtemp: 98.6

Time < 50C: 155 min

## Sensor locations:

T42 - NE corner, 1' from edge

T43 - E, 2' from edge

T55 - W, 3' from edge

T66 - S, 2' from edge

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



# Steam Chamber Construction



Truck Bodies



Walk-in cooler



Shipping Containers

# Siebring steam cabinet

stainless steel cabinet accommodates pallets of pots





## Relative costs of steaming, buying new pots, and wash/disinfect

Units of measurement:

Pallet 42" w x 51" l x 72" h

#1 pots - 2500

#2 pots - 1500

#5 pots - 560

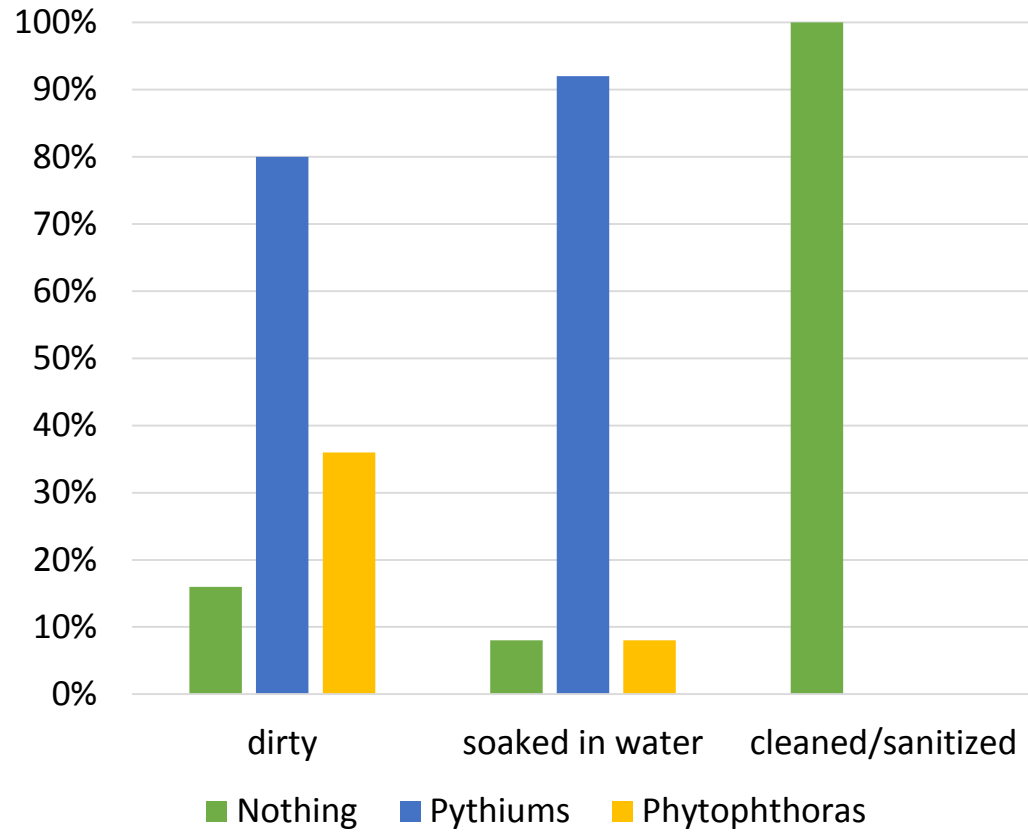
# Disinfectants for tools, pots, and other hard surfaces

- Chlorine bleach – corrosive, do not use on metal tools
- Quaternary ammonium compounds (Greenshield, Lysol, 409)
- Hydrogen peroxide (ZeroTol)
- Alcohol (isopropyl or ethyl)

Wash organic debris off with water (pre-soaking helps) then soak in disinfectant for 10-15 minutes

# Wash/disinfect

Pots 9/2015



# Costs of washing and disinfecting

<b>Fixed costs</b>	#	unit price	final cost
300 gal tank	2	\$ 250.00	\$ 500.00
<b>Consumables</b>			
Greenshield	\$54.00/gal concentrate		
Cost per week for concentrate		\$ 44	
Cost per month for concentrate		\$ 175.50	

It takes one worker two 8hr days to process 1 pallet of #1 and #2 pots = \$240 (8 hr/day, \$15.00/hr)

This becomes 1 month for a truckload of 15 pallets = \$3,800

Disposal of large quantities of disinfectant can be a problem.

## Costs of available portable steam generators.

			<u>loan repayment/yr, 6% interest</u>	
Unit	Lb steam/hr	Price	10 yr	5 yr
<b>Sioux SF20</b>	680	\$45,000	\$5,995	\$10,440
<b>Sioux SF11</b>	385	\$30,000	\$3,997	\$6,960
<b>Siebring SG15</b>	500	\$10,000	\$1,332	\$2,316
<b>Siebring SG12</b>	400	\$7,500	\$999	\$1,740

# Relative costs of all 3 pot sanitation methods:

Assuming 3 truckloads of 15 pallets each containing an average of 68,400 pots (#1, #2, and #5 sizes) per year, and steaming for 4 hrs per load to reach 50C.

## Buy new

Fixed costs: none

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Recurring costs: \$44,418  
(pots)

Worker time: negligible

**Total cost per year: \$44,418**

## Wash/disinfect

Fixed costs: \$500 (soaking tanks)

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Recurring costs : \$2,281  
(disinfectant)

Worker time: \$11,326

**Total cost per year: \$13,607**

## Steam

Fixed costs: \$23,125 (steam generator), \$4,000 (equipment)

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Recurring costs : \$358 (fuel), \$4,222  
(loan repayment)

Worker time: \$360

**Total cost per year: \$4,940 (with loan)  
or \$718 after first year if purchased  
outright.**

Questions?

