The Horticulture Behind Phytophthora Management

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Managing Phytophthora Workshop

Phytophthora root rot

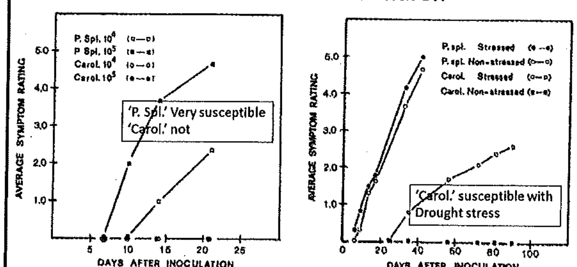
Photo by Ted Swiecki, Phytosphere

Photo by Suzanne Lathram, CDFA

Presentation Outline

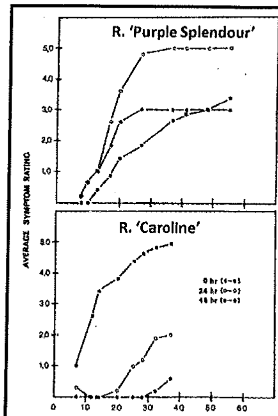
- The occurrence, severity and spread of Phytophthora diseases are affected greatly by the cultural practices in the nursery.
- Besides sanitation, soil and water management are some of the most important cultural practices to control Phytophthoras. (They are water molds afterall!)
  - Know your soil. Soil physical characteristics affect air and water in a container.
  - Irrigation management and salinity control is important.

Effect of drought stress on Phytophthora root rot on Rhododendron



- R. 'Purple Splendour' and R. 'Caroline' grown with or without drought stress (wilting)
- Roots inoculated 24 hours with *P. cinnamomi* zoospores then followed by normal irrigations
- Disease symptoms: 0 = healthy 5 = dead plant

Blaker and MacDonald, 1981

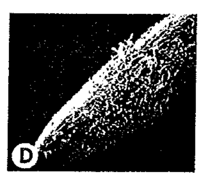


Effect of flooding on Phytophthora root rot on Rhododendron

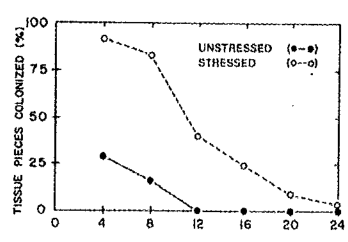
- Plants held for 0, 24, or 48 hrs
- Inoculated with *P. cinnamomi*
- Disease symptoms:
  - 0 = healthy
  - 5 = dead plant
- No significant differences in highly susceptible 'Purple Splendour'
- Significant differences in 'Caroline'

Blaker and MacDonald, 1981

Effect of salinity stress on susceptibility to chrysanthemum roots to Phytophthora



Zoospores of *P. cryptogea* colonizing root tip of salt stressed root.

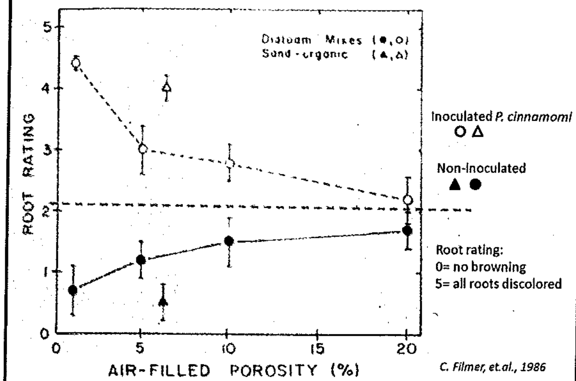


More rapid colonization of roots with salt stress

J. MacDonald, 1982 and 1984

- 24 hour root exposure to a high salts in hydroponics.
- Inoculated with zoospores of *P. cryptogea*.
- Incubated for 48 hours.

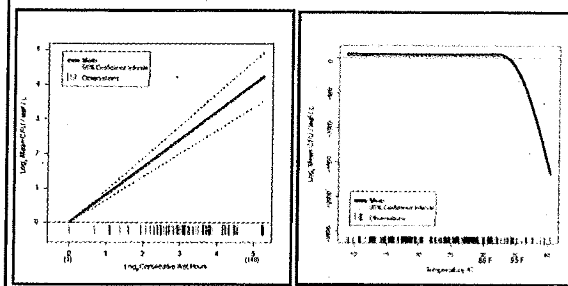
Air-filled porosity affects Phytophthora root rot on toyon



C. Filmer, et.al., 1986

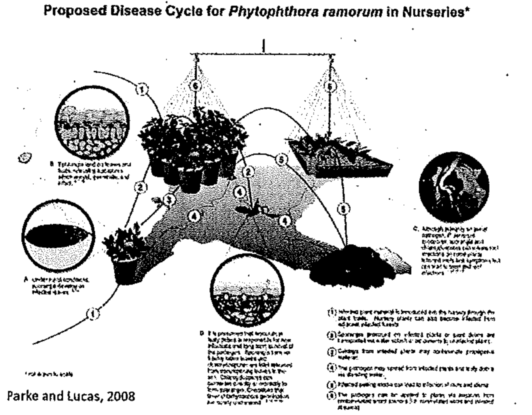
Foliar sporulation of Phytophthora ramorum on Rhododendron in field conditions

Leaf Wetness Duration (hours) | Temperature



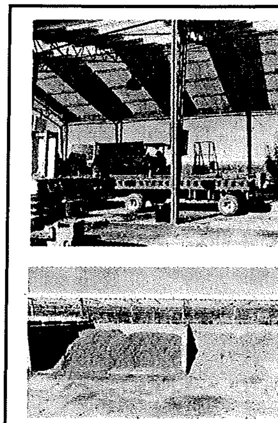
Tjosvold, Chambers, and Mori, 2013

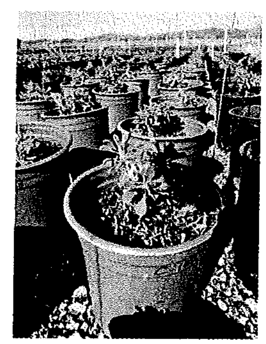
Proposed Disease Cycle for *Phytophthora ramorum* in Nurseries*



Parke and Lucas, 2008

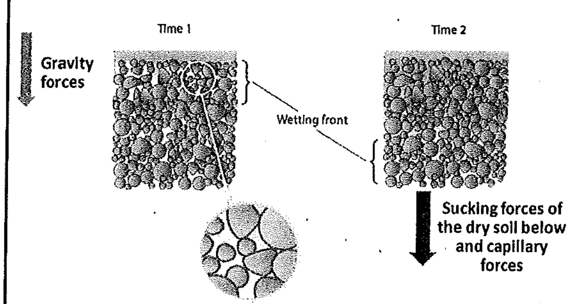
What's unique about container soils?





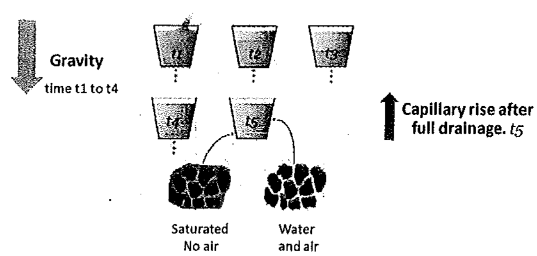
Water movement in field soil

Affected by fine particles and no depth restriction



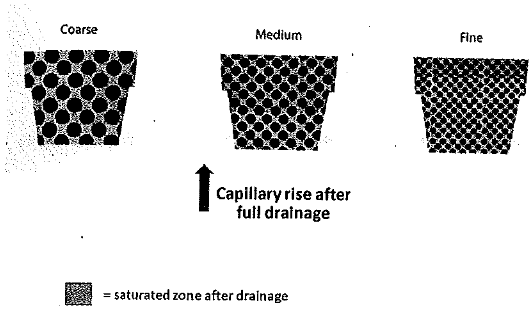
Water movement in a container soil

Affected by coarse particles and bottom interface

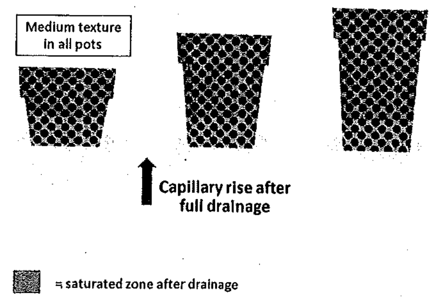


When a pot is fully drained there will be a perched zone at the bottom of the pot

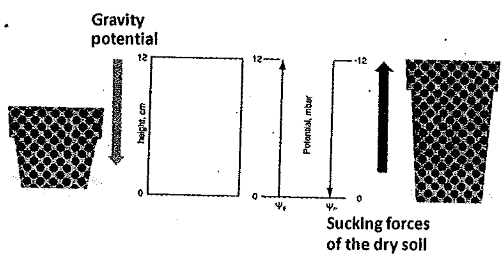
Saturated (perched) zone after full drainage is dependent on soil texture



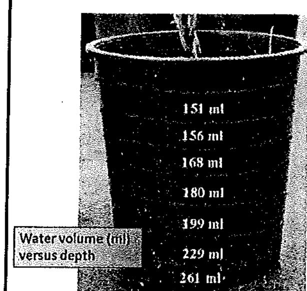
Saturated (perched) zone after full drainage is not dependent on container depth



The soil above the perched zone drains depending on the depth of the pot.



An example of the volume (ml.) of water and air at each depth after full drainage



Total Porosity	Water	Air
261	151	110
261	156	105
261	168	93
261	180	81
261	199	62
261	229	32
261	261	0

Photo by James Altland

- For a given soil mix, shorter containers will hold more water and less air.
- A high water holding capacity soil may not be suitable for a short container or liner.

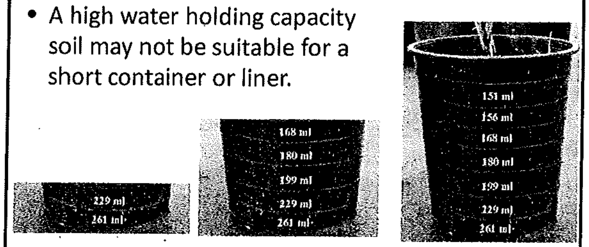


Photo by James Altland

Degree of dryness (sucking forces) can be measured by a tensiometer and be used for scheduling irrigations

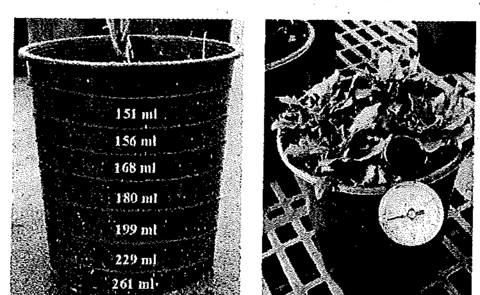


Photo by James Altland

So do you get why this happens?

The "Ideal" Container Medium

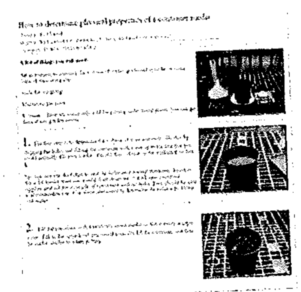
- Total porosity: 60-75%
- Water volume (after drainage) or "water holding capacity": 50-65%
- Air volume (after drainage) : > 10%
- Water volume *available for plant uptake*: > 30%

Physical Properties of Selected Media

Total Porosity %	93	94	73
Water Holding Capacity %	73	81	62
Air volume %	20	13	11
Available water %	48	60	44

Measured in a 12 cm tall container (a " 6 inch pot")
Peat +Perlite 1:1 v/v
Peat + Vermiculite 1:1 v/v
U.C. Mix = 1:1:1 v/v of sand, redwood shavings, peat

Measure total porosity, water holding capacity and air-filled porosity



See handout by James Altland

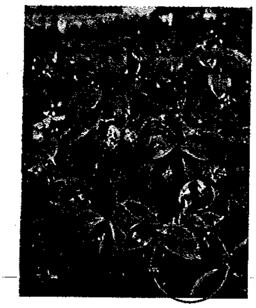
Which leads back to this

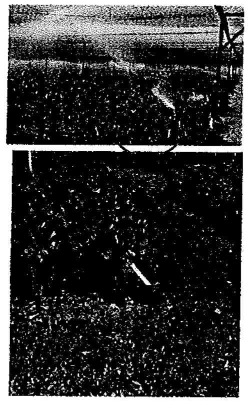
Photo by Ted Swiecki, Phytosphere

Photo by Suzanne Lathram, CDFA

Be careful with:

- Variation in composts
  - Composition and rate of decomposition may vary
- Nitrogen depletion with organic decomposition
- Sludges
  - Fine textures, heavy metals, odor
- Field soil
  - Fine texture, pathogens, weed seeds
- Soil settling
  - Can result in loss of large pores and therefore air



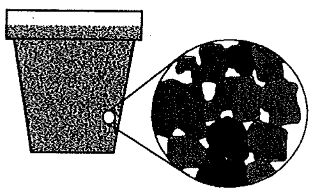


Irrigation scheduling is important for disease control

How to schedule irrigations

- When is irrigation needed?
  - When half the available water is used
    - Use a tensiometer
    - Weigh pots
  - Irrigate in morning so leaves can dry quickly.
- How much total water needs to be applied?
  - Replace plant water use
  - Compensate for salinity
  - Compensate for poor irrigation distribution

Matric potential: the energy required to remove water from the substrate "It sucks"

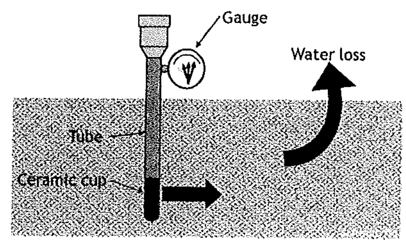


Kilopascals (kPa)

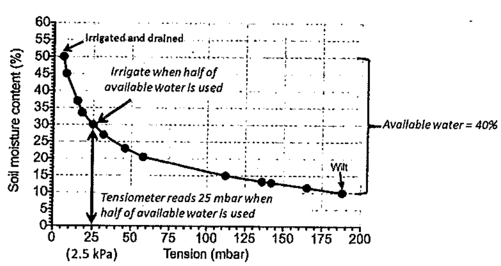
Pounds per square inch (psi), Bars or centibars (cbar) or millibars

Soil moisture measurement

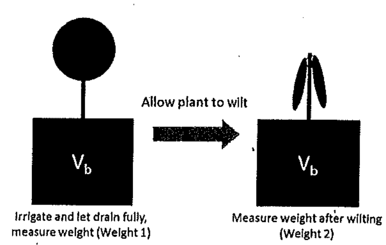
Tensiometers



Example: using a moisture release curve
Irrigate when half the available water is used



Measuring available water without a moisture release curve



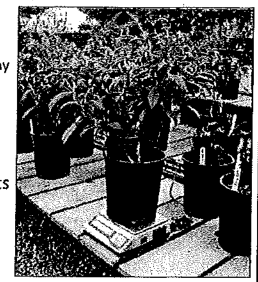
$$\text{Available water} = \frac{\text{Weight 1 - Weight 2}}{\text{Soil volume } (V_b)} \times 100\%$$

Available water is the pot's fuel tank capacity

Substrate	Water-holding capacity (% vol)	Available water (% vol)
Peat:perlite (1:1)	51	41
Peat:vermiculite (1:1)	81	62
UC mix (1 sand : redwood sawdust : 1 peat)	52	43
Elder sandy loam	23	13
Baywood loamy sand	13	8
Watsonville loam	37	16

Decide when to water

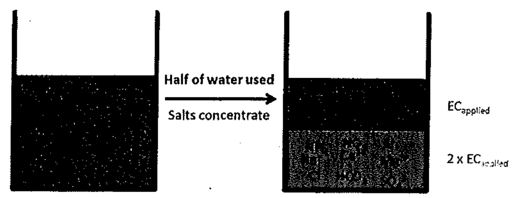
- Weigh pots daily
  - change in grams during a 24-hr period represents milliliters of water lost per day by evapotranspiration.
- Irrigate when half of the available water is used.
- Conveniently, that is the amount of water to apply with some adjustments



Manage Irrigation Schedule

- How much total water needs to be applied?
  - Replace plant water use
  - Compensate for salinity
  - Compensate for poor irrigation distribution

Salts accumulate in the substrate between irrigations.



$EC = EC_{applied}$

$EC = \frac{EC_{applied} + 2 \cdot EC_{applied}}{2} = 1.5 \times EC_{applied}$

Manage salinity by applying the appropriate leaching fraction.

- $\text{Leaching fraction} = \frac{\text{Volume of water leached}}{\text{Volume of water applied}}$
- To select leaching fraction, divide $EC_{applied}$ by tolerable leachate EC.
  - Most crops tolerate leachate EC of 6 dS/m to 9 dS/m.
  - Salt-sensitive crops tolerate 3 dS/m.

See handout

Manage Irrigation Schedule

- How much total water needs to be applied?
  - Replace plant water use
  - Compensate for salinity
  - Compensate for poor irrigation distribution

Irrigation systems efficiency affects total water applied

Drip emitter or tape + 10 %

Hand watering + ?

Impact or mini sprinkler +10 to 60%

Adjust irrigation volume to meet plant needs and leach.

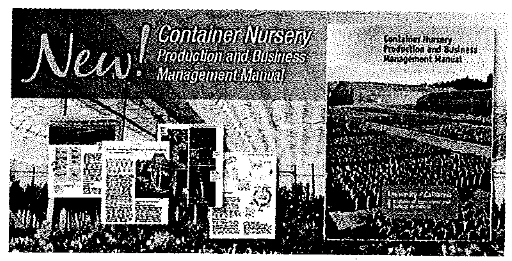
- Apply enough to replace evapotranspiration — 255 mL
- Correct for the leaching fraction (e.g., add another 84 mL if LF = 0.25) — + 84 mL = 339 mL
- Correct for distribution uniformity (divide total above by DU) — 565 mL

$$\frac{ET+LF}{DU}=\frac{339}{0.6}=565$$

Correction for the water quality and a low DU may require more water than the plant does!

Conclusions

- The occurrence, severity and spread of Phytophthora diseases are affected greatly by the cultural practices in the nursery.
- Besides sanitation, soil and water management are some of the most important cultural practices to control Phytophthoras. (They are water molds afterall!)
  - Know your soil. Soil physical characteristics affect air and water in a container.
  - Irrigation management and salinity control is important



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