

Slow Sand Filters

Remove *Phytophthora*
and TMV from
captured runoff

Lorence R. Oki, Ph.D.
Department of Plant Sciences
University of California



Photo: L. Oki

California Nursery Conference
Watsonville, CA
October 25, 2016

Slow Sand Filtration



- What is slow sand filtration?
- System design and operation
- Research results



What is Slow Sand Filtration?

Sand Filters

- ▣ Rapid sand filtration
- ▣ Slow sand filtration



What is Slow Sand Filtration?

Rapid sand filtration

- ▣ Coarse sand ($>1\text{mm}$)
- ▣ Removes larger particles only
- ▣ Does not remove pathogens
- ▣ Does not remove pollutants
- ▣ 2-20 gpm/ft²
- ▣ Low maintenance



What is Slow Sand Filtration?

Slow sand filtration

- ▣ Removes pathogens
- ▣ Removes many pollutants
- ▣ Low maintenance
- ▣ Slow flow rates
 - 0.06-0.2 gpm/ft² (33-100× slower)
 - 12' dia tank can treat 10,000 gpd

Mechanism

- “Schmutzdecke”
 - Where most treatment occurs
 - ▣ A community of microorganisms
 - ▣ Sand bed surface to 6 inches below
- Organisms that have been identified:
 - ▣ algae, bacteria, diatoms, and zooplankton
- Mechanisms for removal are not fully understood
- Particulate removal before filtration

Capabilities



Can remove

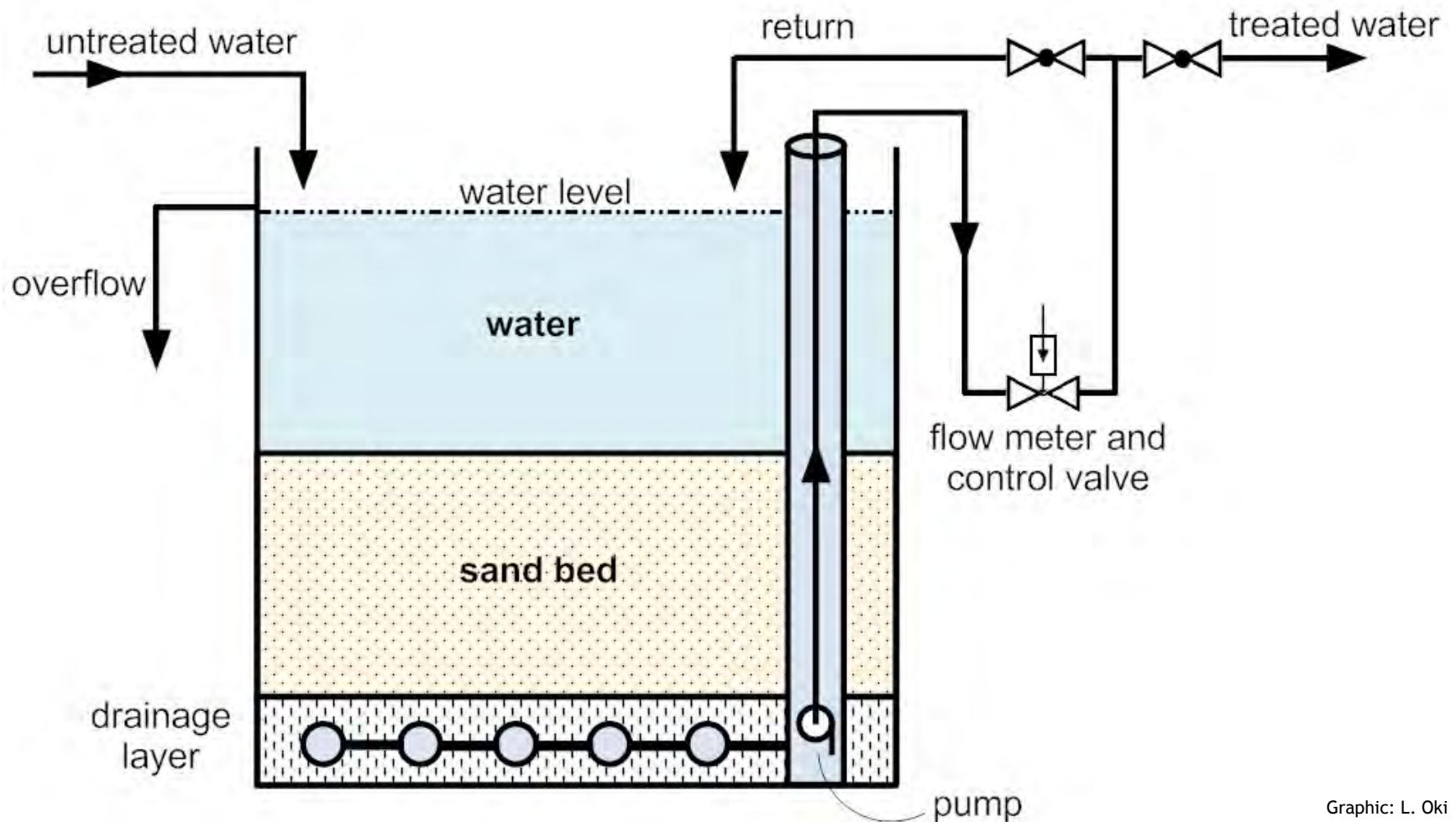
- Pathogens
- Nutrients
- Chemical pollutants



Specifications

- Uniform particle size
 - ▣ 30-60 mesh (0.425-0.3mm)
 - ▣ Uniformity Coefficient (UC)<3
- Round, not sharp
- 1m water head over sand
- Sand must stay submerged
- Sand surface must not be disturbed
- Flow control
- Recommend 1m sand depth
- Recommend at least two filters

System Design



Installations



Berylwood Tree Farm, Somis

Installations

Roundstone Nurseries, UK

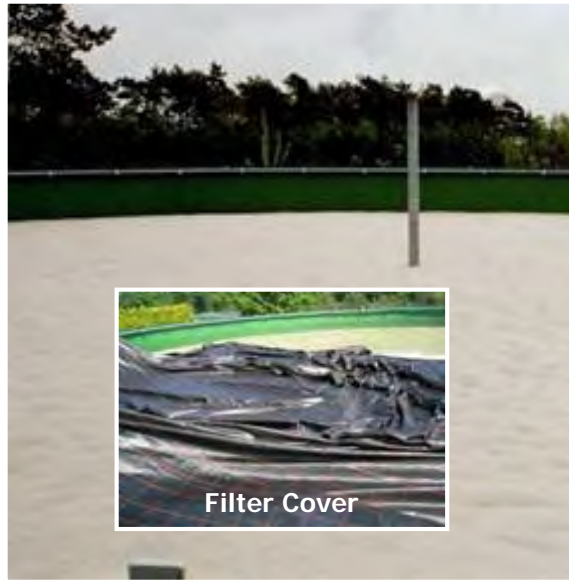
- 850 ft² surface
 - ▣ 33 ft dia.
- 60,000 gpd
- Treated storage
 - ▣ 132,000 gal
- Untreated storage
 - ▣ 1,720,000 gal



Horticultural Development Council, 2005

Installations

350,000 gpd
~4,440 sq.ft



Filter surface (sand)

Underdrain system (lowest level)



Supernatant water

From: Sabine Werres, Federal Biological Research Center
for Agriculture and Forestry, Braunschweig, Germany

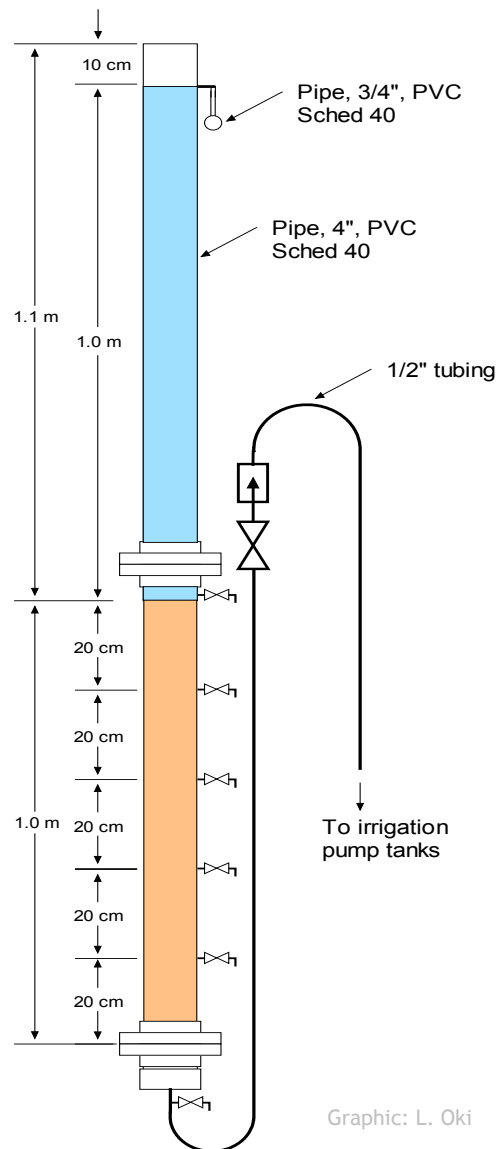


Experimental Design

Flow rates and time-to-treatment

- Generate and capture irrigation runoff
- Inoculate treatment water
 - ▣ *Phytophthora capsici*
- Collect water samples
 - ▣ Pretreatment
 - ▣ From within sand bed
 - ▣ Post treatment
- Analyze for *P. capsici*

SSF Studies

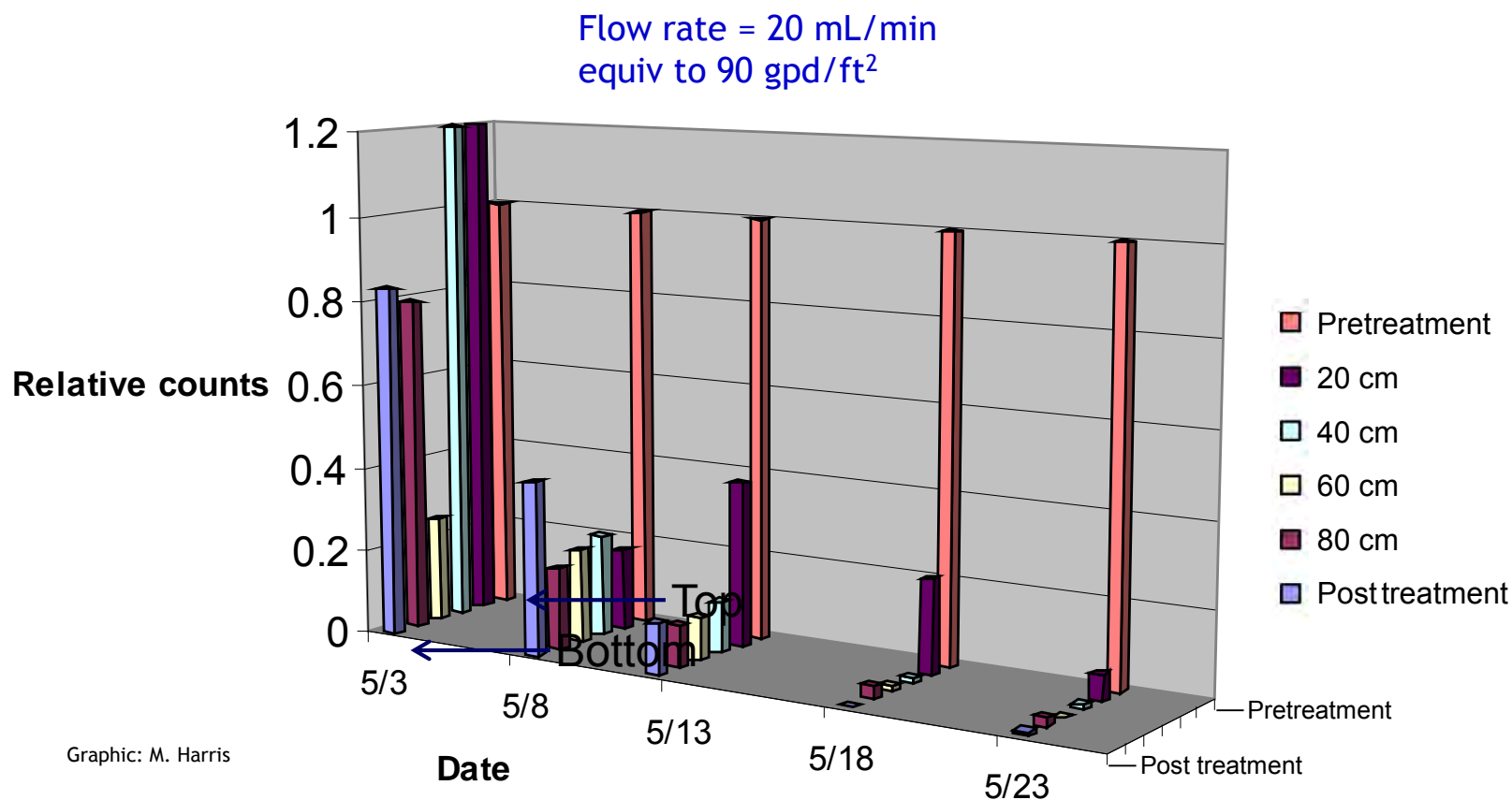


Graphic: L. Oki



Photo: L. Oki

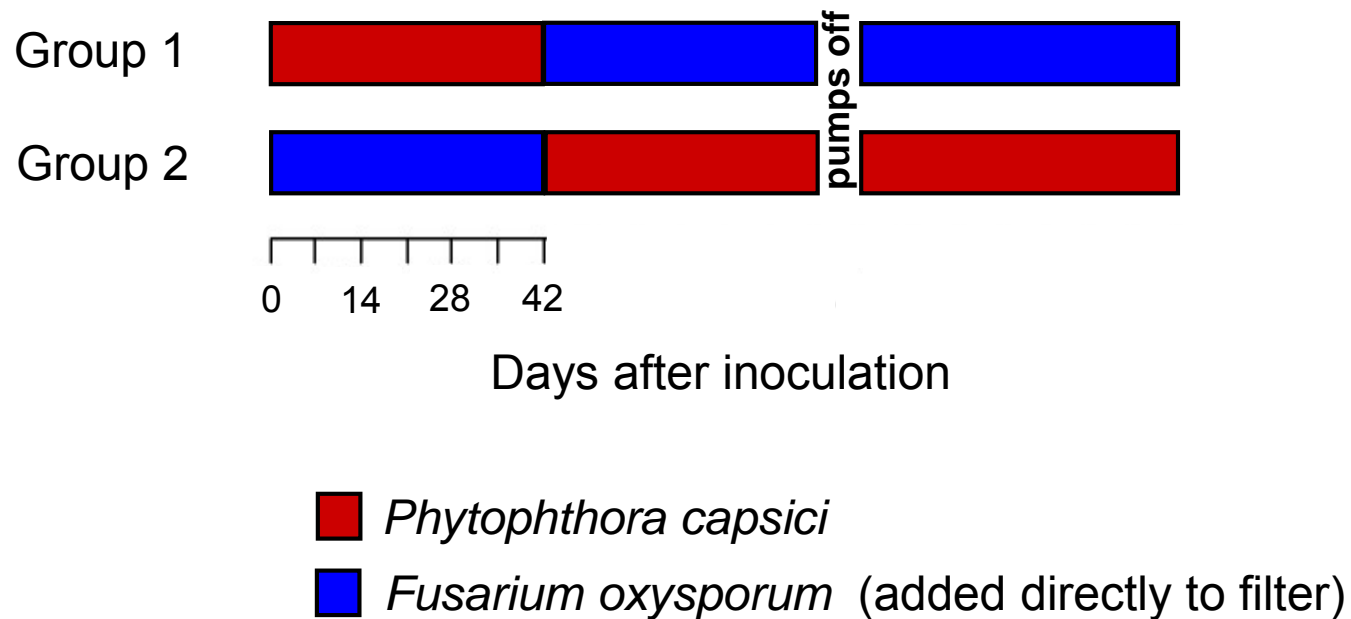
Treatment Performance



Graphic: M. Harris

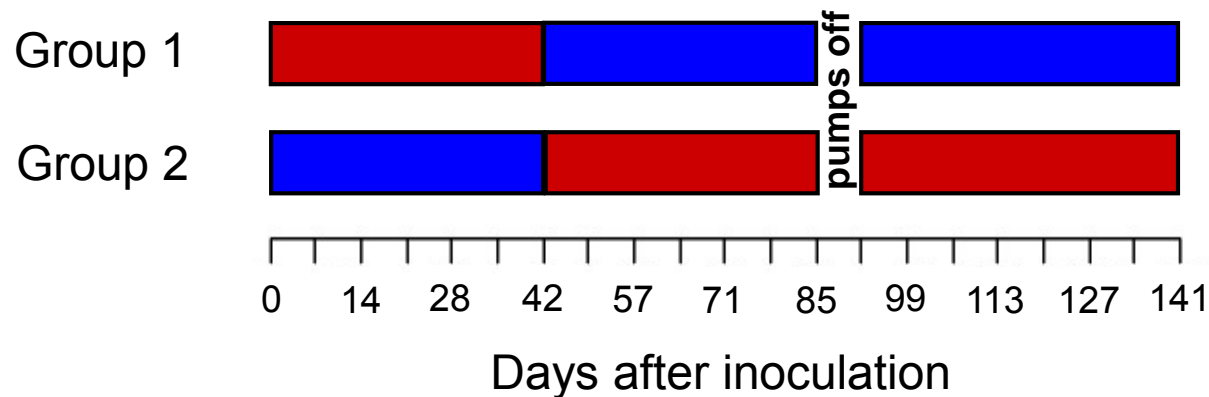
Pathogen switch

And simulated pump failure



Pathogen switch

And simulated pump failure



- *Phytophthora* always removed
- Could not remove *Fusarium*
 - It is possible with “priming”

Virus removal

- Purified TMV added to columns
- Collected water samples weekly
- Testing via
 - ▣ ELISA
 - ▣ bioassay
 - *Leaf- N. glutinosa, C. quinoa*
 - *Whole plant- N. tabacum, N. benthamiana*
- Required 6-9 weeks to achieve removal

Virus removal, bioassay results

	Column 2	Column 3	Column 4
TIME	N.b./N.t.	N.b./N.t.	N.b./N.t.
-0	-/-	-/-	-/-
24 hrs	+/+	+/+	+/+

← Before TMV addition

Samples from
below sand bed

Systemic hosts
Nicotiana benthamiana (N.b.)
and *N. tabacum* (N.t.)


Current and future work



Conclusions

Biological treatment systems:

- Require little or no inputs
 - ▣ Contrast with energy (UV irradiation) or chemical-based (chlorination) methods
- Can remove pathogens, chemical pollutants, and nutrients
- Low flow rates means space is required to hold large volumes of water



Thank you
lroki@ucdavis.edu