Kearney Foundation Fellowship
Final Report Summary - Due August 31, 2010

Fellowship Recipient's Name: Julie Escalera
Project Title: Effects of irrigating citrus with reclaimed water
Mentor Professor's Name: Dr. Chris Amrhein
Reporting Period: 2009/2010 Academic year
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1. Project objectives and status:

Introduction

Drought and water shortages are becoming an unavoidable crisis in arid regions. Reclaimed water is seen a good alternative to higher quality well water. However, reclaimed water can decrease saturated hydraulic conductivity in the soil due to its higher concentration of dissolved salts and sodium. Sodium reduces hydraulic conductivity by swelling and dispersing clay particles in the soil thus reducing the water-conducting pores. Reduced water infiltration may cause ponding, root rot, and damage to crops.

The objective of this experiment was to determine how reclaimed water will affect the hydraulic conductivity of soils found in the Greenbelt area of Riverside. Particular attention was given to horizons of clay accumulation since they are expected to show a greater reduction in hydraulic conductivity. The surface horizon and a deeper horizon were selected for evaluation. Blending water, mixing lower salinity water with reclaimed water is a common practice to improve water quality. Therefore, a blend of reclaimed water and the control was included as a treatment in this experiment.

Methods

The sample location was a mature orange grove located in the Riverside Greenbelt area, GPS coordinates 33^{o} 53’ 30” N, 117^{o} 25’ 59” W. The soil found in this orchard was representative of other soils located in the Greenbelt area and is classified as an Arlington loam. Moisture temperature regime is xeric with dry hot summers and cool winters.

Site locations were selected with a random sample model. EPA hand auger soil sampling procedures were implemented using a continuous sample method. The sample site was located in the irrigation furrow approximately 2 meters away from the base of the tree. Soil was collected with a 3 inch metal hand auger. After collection, the soil was air dried at 120 ^{o}F. Then, the soil was hand sieved through a 2 mm sieve to remove gravel from the fine earth fraction. The surface horizon and a deeper horizon were selected for analysis; 0-20 cm and 40-60 cm. Soil texture was determined in the lab with Particle Size Analysis. Bulk density and organic matter content were determined in the lab. See soil data chart.

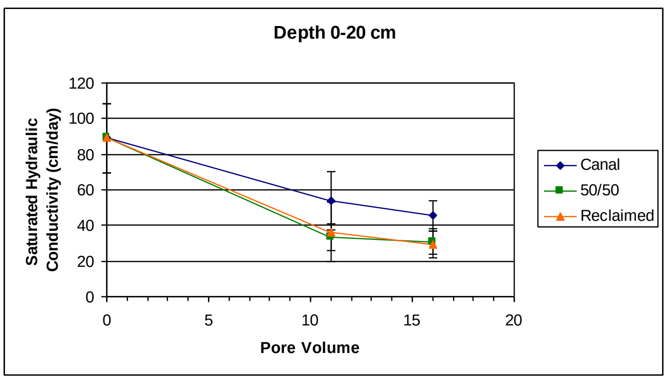
Depth	% Clay	% Silt	% Sand	BD g/cm3	% OM
0-20cm	18	38	44	1.54	1.04
40-60cm	19	41	40	1.61	.89

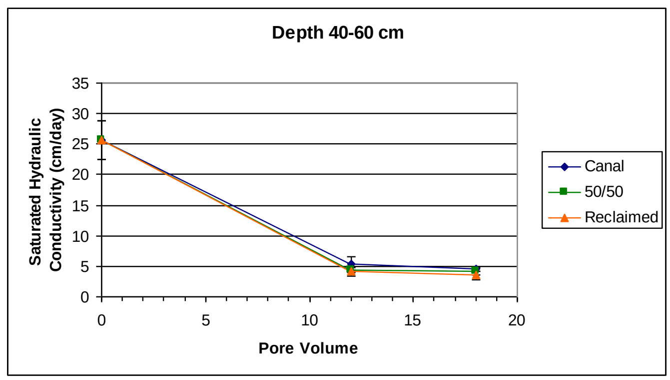
The soil was packed in 15 cm PVC columns with a 5 cm inside diameter. One end of the column was covered with cotton gauze and the edges of the gauze were taped to reduce evaporative loss. Each column was filled with 200 g of soil in 50 g increments. Soil was packed to approximately the same density by using a drop-compactor. Initial hydraulic conductivity rates were measured using Gage Canal water. Because Gage Canal water has been used to water these orchards for over 130 years, Gage Canal water was used as a control. Saturated hydraulic conductivity (Ksat) was determined using Darcy's Law with a constant-head model. Columns were allowed to reach a steady state before rates were measured. Three water treatments were selected. See chart attached. Water was applied in 100-200 mL increments. To simulate field conditions, columns were allowed to dry between applications of water.

Water Quality	**Gage Canal (Control)**	**50/50 (reclaimed/control)**	**Reclaimed**
EC (mS/cm)	**0.58**	**0.77**	**0.90**
pH	**7.9**	**7.9**	**7.6**
Alk (mg/L $CaCO_3$)	**165**	**177**	**177**
SAR	**0.60**	**1.3**	**1.8**

Results

In the deeper horizon, depth 40-60 cm, there was no significant change in hydraulic conductivity. In this depth all treatments reduced hydraulic conductivity and the control was not statistically different from the reclaimed water and 50/50 treatment. See attached graph.
In the surface horizon, 0-20 cm, there was a significant difference in hydraulic conductivity in the reclaimed water and the 50/50 treatment when compared to the control. The saturated hydraulic conductivity for the 50/50 treatment and the reclaimed water treatment decreased by 16-18% compared to the control. See attached graph.





Conclusion

The surface horizon, depth 0-20 cm, showed the greatest overall reduction in saturated hydraulic conductivity for the reclaimed and 50/50 treatment when compared to the control. All treatments showed a significant decrease in saturated hydraulic conductivity which may be due to formation of vesicular pores inside the columns. The results based on the surface horizon data suggest that farmers might have to change their irrigation practices or add gypsum to the soil if they use reclaimed water for irrigation.

A reduction in saturated hydraulic conductivity was seen in all treatments which may be due to formation of vesicular pores. Future research will focus on how vesicular pores form in these soils and if reclaimed water accelerates the formation of the vesicular pores.

2. Describe the major challenges and opportunities or other pertinent information important in the overall achievement of your project.

One of the greatest challenges in this project was that hydraulic conductivity decreased in all of the treatments. Once we broke the columns apart we discovered vesicular pores had developed in the soil, a phenonmena not anticipated. Previous studies have shown that vesicular pores do not develop in agricultural soil. Research on vesicule formation, hydraulic conductivity and its impact on agricultural practices was an unexpected and exciting outcome of this project.