CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

38164

Project Title

Irrigation Water Usage Efficiency Improvement by Modification of Root Zone Soil Properties Using Carbon Sequestration

Abstract

Objectives/Goals

Irrigation consumes more than 80% of the world#s fresh water. The exploding global population and increasing food demands lead to water shortage. Improving the efficiency of irrigation will help to mitigate water stress. The purpose of this project is to study the effects of root zone soil modifications on soil water retention using a percolation control layer amended with charcoal.

Methods/Materials

The design of experiments# study was conducted by varying Percolation Control Layer (PCL) thickness, percentage of charcoal amendment, and the grain size of charcoal added. Statistical analysis predicted that the water retention increases with increasing PCL thickness, increasing charcoal amendment percentage, and decreasing charcoal grain size. One reference bed with surface irrigation is compared to a) insert and top soil bed and b) insert, top soil bed and PCL layer at the root zone (with both coarse and fine grain charcoal amendment). Beds are watered as determined by container samples' weight loss and evapotranspiration calculation based on daily weather parameter data. Radish weights were compared from four beds. Scanning Electron Microscope images of coarse and fine grain charcoal samples were taken at 1000x magnification.

Results

With 33% charcoal amendment, 4 cm PCL thickness, and two charcoal grain sizes, field tests were conducted with radish and green pea plants. The PCL with charcoal amendment showed 49% lower water consumption while also producing 50% higher radish yield. The yield improvements were statistically significant as shown by t-ratio of 2.26. SEM analysis showed coarse grain charcoal had higher surface roughness.

Conclusions/Discussion

Charcoal amendment increased water retention at the root zone maximizing water usage by the plant transpiration. Optimized beds used less water while producing higher yield (radish weights and leaf size). Coarse grain charcoal#s rough surface can lead to effective adsorption of nutrients, enhanced microbial activity and consequently better root health and plant growth. In addition, charcoal amendment results in carbon sequestration, which reduces greenhouse gas emission and ultimately can reverse climate change.

Summary Statement

Using carbon sequestration (charcoal amendment) soil properties are modified to reduce irrigation water usage by 49%, while improving plant yield by 50%.

Help Received

Dr. Fred Barez helped me with data analysis methods. Mr. David Tuttle gave suggestions on bed preparation at the farm. Mr. Greg Rudd showed me how to prepare samples and take images using SEM.