Name(s)

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Project Number

S1125

Project Title

Desertification Mitigation: To Grow Plants in Sand with Suppression of Percolation Water Loss Using Sequestered Carbon

Abstract

Objectives

Global population will exceed 9 billion by 2050. Food Production has to increase to meet the demand. Agriculture/Irrigation consumes 80% of the world's fresh water. Climate change is leading to increasing Aridity/Desertification and diminishing available water. This project focusses on methods to grow plants in sandier soils and also to reduce the amount of fresh water needed for irrigation by mitigating evaporation and percolation losses. Hypothesis: a) By using Percolation Control Layer (PCL) at the root zone it is possible to grow plants in the sand with a comparable yield to plants grown in soil, b) Compaction of PCL will improve water retention, and c) With PCL alone more than 25% water can be conserved.

Methods

Design of Experiments was conducted using nine samples. Water was added to the insert in the upper container until it begins to percolate through the netting base. After eight hours, the weight gain of the lower container is used to estimate water retention %. JMP statistical package was used to determine that compaction and PCL thickness had the largest impact on retention %. Radish and Kale were grown in containers with pure sand and with sand and PCL. Water addition was controlled to match the daily water loss over 70 days period.

Results

With PCL in the sand, both radish plants and kale plants show a 30% reduction in experimentally measured water use, while the plant weight and leaf size doubled. Theoretical predictions by Penman-Monteith calculation using local weather data agreed with experimental water usage. SEM images of roots grown in sand with PCL suggest microbial activity. Charcoal SEM shows 20µm pores while the hyphae of mycorrhizal fungi are 2µm wide.

Conclusions

The texture on the surface of the charcoal walls facilitates nutrient adsorption and mitigates the loss of nutrients through leaching. Soil can hold more carbon than the atmosphere, and hence carbon sequestration in the form of charcoal under the soil surface reduces net carbon dioxide emission. Compaction affects aeration of roots and requires further study. When plants grow at the boundary of the desert, soil erosion and desertification can be mitigated. Dense plant root structures will help to retain more water in deserts. PCL reduces water use by 30% while increasing plant yield by 30%.

Summary Statement

With charcoal amended soil layer at the root zone percolation reduction, root health, carbon sequestration can be achieved in sandier soils.

Help Received

Dr. Greg Rudd, Technology Manager at Spectra-Mat, trained me to sputter my charcoal and root samples with gold and with sample preparation/imaging on the Scanning Electron Microscope (SEM). Dr. Fred Barez, San Jose State University mentored me discussing my ideas/experimental methods.