The use of clinoptilolite zeolite as a soil amendment to reduce evaporation rates in sandy soils

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Introduction

Conservation of water is crucial in arid environments where water is scarce. Sandy soils of the southwestern United States where rainfall is less than 9 inches/year are prone to high evaporation rates due to their larger pore space, thermal properties of soil minerals mixed with water, and prolonged drought (Repetto et al. 2012). In the agricultural industry, farmers are seeking alternatives to reduce soil evaporation so that irrigation water is put to beneficial use of growing crops. This study assessed the use of clinoptilolite zeolite (CZ) as an amendment to sandy soils in order to reduce evaporation depletion. The hypothesis is that CZ when added to soil will reduce evaporation because of its crystal lattice structure and its ability to hold high water content (Breck et al. 1974).

Methodology

Zeolite was added to sandy loam soil collected at ReNUWIt Sunland Park Test-Bed site and mixed at volume ratios (CZ:SL) of 20%, 40% and 60% and placed in a total of 9 five-gallon buckets that were perforated at the bottom. An additional five-gallon bucket of 100% CZ and two buckets of sandy loam soil were also included in the experiment as a control. Clean water at room temperature was added to the buckets until the soil was fully saturated. The saturated soil was left to drain by gravity until no water was coming from the bottom of the bucket in order to achieve soil field water capacity. After the soil reached field capacity, their weights were then determined using a scale every morning thereafter until the soil was very dry. Soil Temperature readings were taken at the surface (1 in.) and sub-surface (7.25 in) in ten minute intervals daily. A CR1000X datalogger, AM32/16A multiplexer, copper-constantan thermocouple wiring, and a solar batter were used to take temperature readings. Volumetric Water Content was calculated using a water reflectometer.

Objective

The objective of this project is to determine if zeolite, when added to sandy soils as an amendment, can reduce evaporation.

Results

Evaporation rates varied from one day to another due to fluctuations in ambient temperatures. Total evaporation during three and two days are shown in **Figure 1**, respectively. The results show that evaporation depletion decreased with an increase in zeolite percentage ratio in sandy soil. Preliminary results from this study show that by adding zeolite to sandy soils, evaporation depletion can decrease from 8% to 30%. A decrease in evaporation depletion for different CZ-Sand ratios was inconclusive due to minimum number of drying cycles (only two cycles). Further data collection for different drying cycles is recommended to determine if there are any significant differences between the mixing ratios.

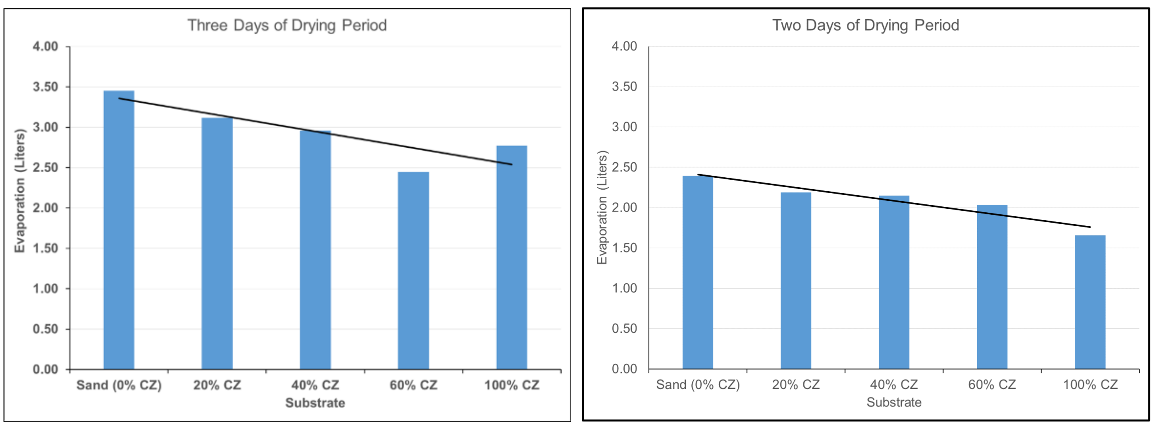

Figure 1.

Temperature of the substrates followed diurnal ambient temperatures. A significant difference in temperature was observed between sand (0% CZ) and CZ (100%) reaching up to 9 ^{o}C. No significant difference in temperature was observed for other mixtures. Location of the buckets in the experimental setup may have affected the bucket temperatures depending on their exposure to the sunlight and the surrounding. Temperature measurements of soil, CZ and the mixtures are shown in **Figure 2**.

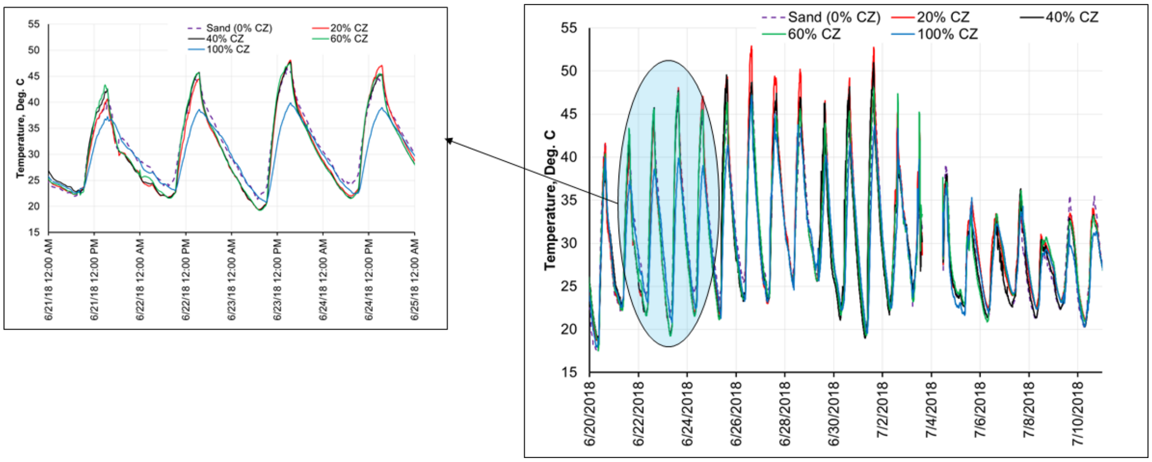

Figure 2.

Conclusion

Addition of zeolite to sandy soils reduced evaporation. Evaporation rates decreased as the percentage of zeolite ratio to sand increased. The evaporation rates reported here are for 2 cycles only of wetting and drying. It is recommended that more data be collected for more drying cycles. The temperature of moist zeolite was significantly lower than that of the sandy soil.

References

Breck, D.W. (1974). Zeolite Molecular Sieves, Structure, Chemistry and Use. New York, J. Wiley: 771 pp.

Repetto, R. (2012) New Mexico's Rising Economic Risks from Climate Change.

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