Comparative Effects of Soil Amendments on Soil Evaporation under Controlled Conditions

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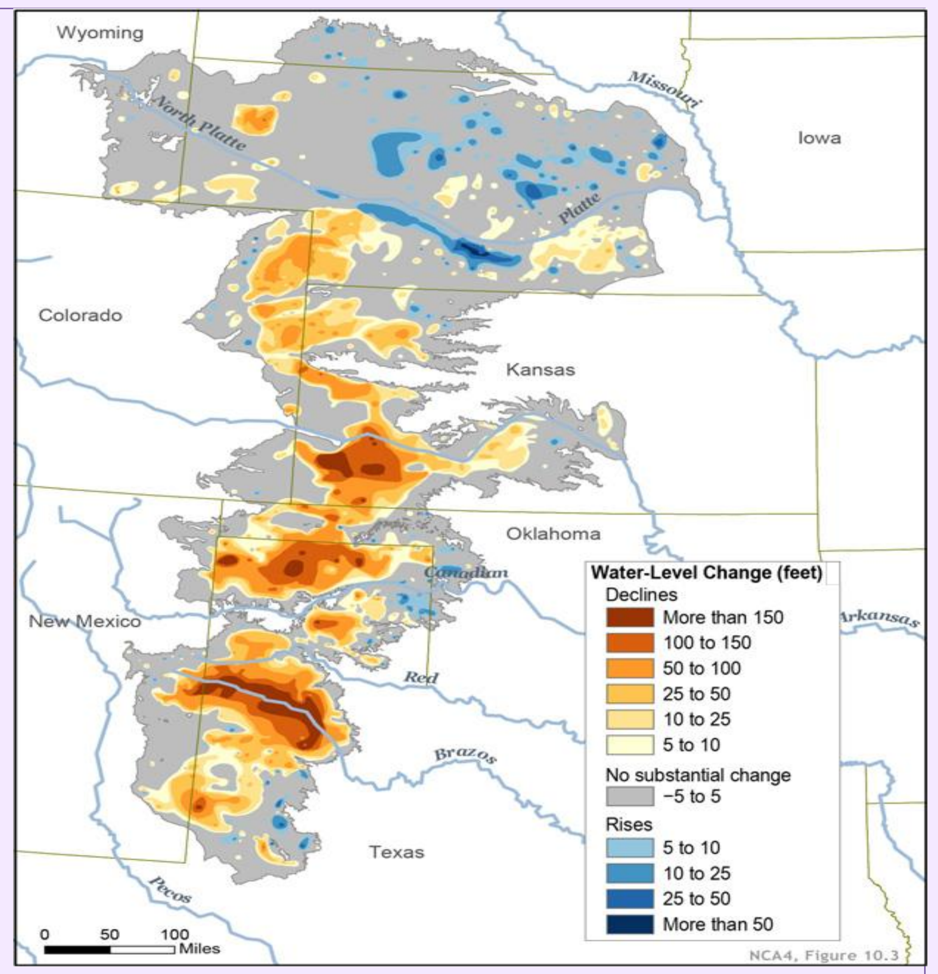
Background

- The Ogallala Aquifer's decline threatens agricultural sustainability in the Central High Plains.
- Biochar and *Bacillus subtilis* (which produces Surfactin) help reduce soil evaporation and improve water retention.



https://www.climate.gov/media/10241

Experimental apparatus

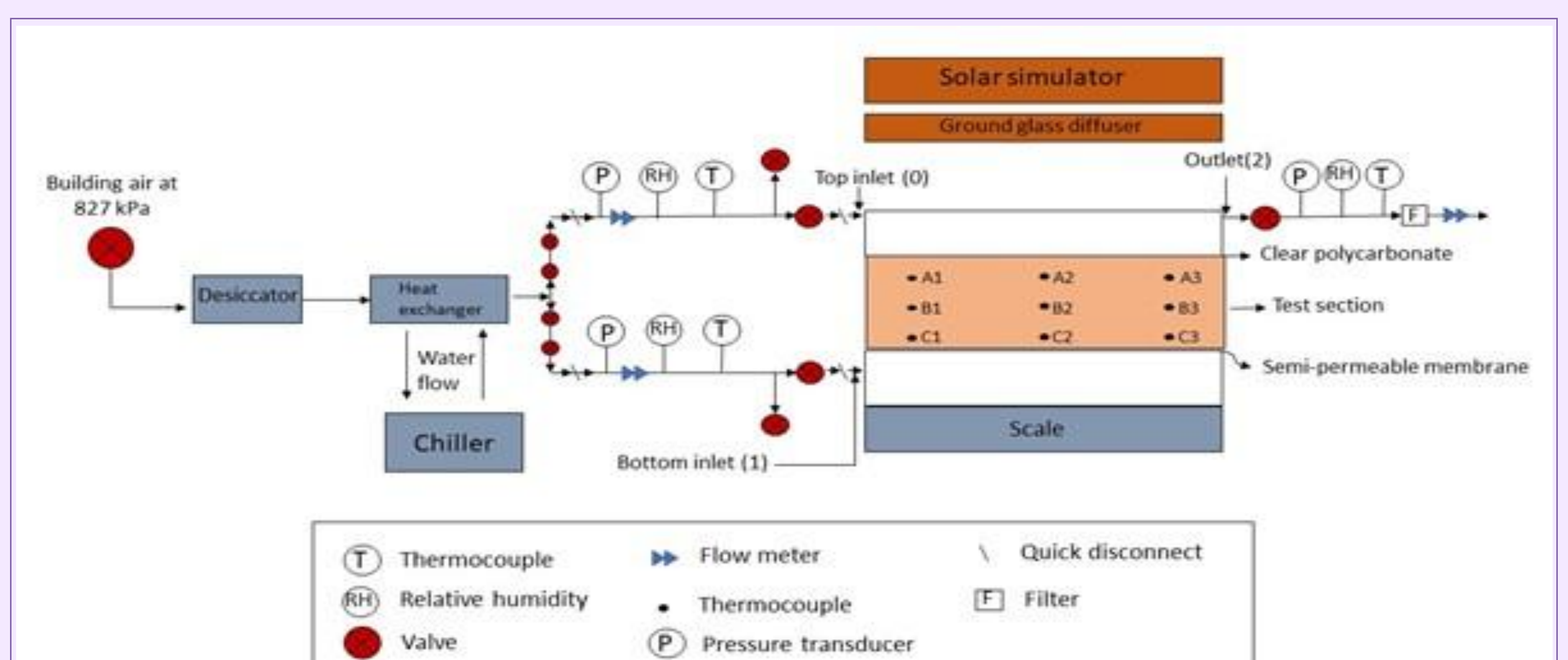


Fig 1. Schematic diagram of the experimental apparatus

- Custom-built evaporation chamber containing 14 kg sandy loam soil (64% sand, 16% clay, and 20% silt); evaporation rate determined from airflow mass balance.
- Treated with 3% (mass basis) wood-derived biochar and 0.017 mg Surfactin per gram of soil.

Fig 2. Experimental apparatus with simulated solar flux

Key Findings

Introducing biochar and Surfactin (produced by *B. subtilis*) into the soil can reduce evaporation during the slow-evaporation phase, conserving soil water.

Effect of biochar (wood-based)

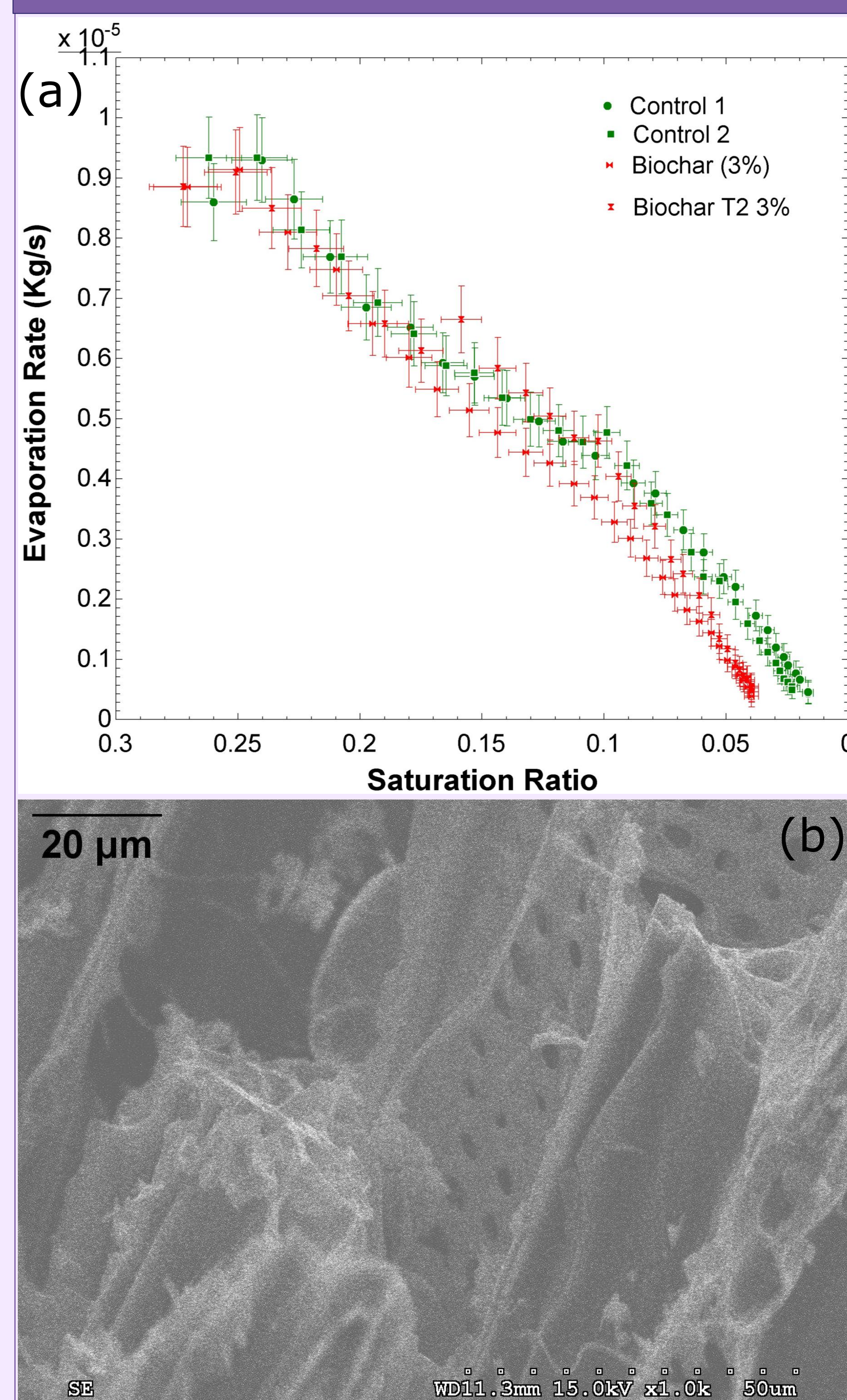
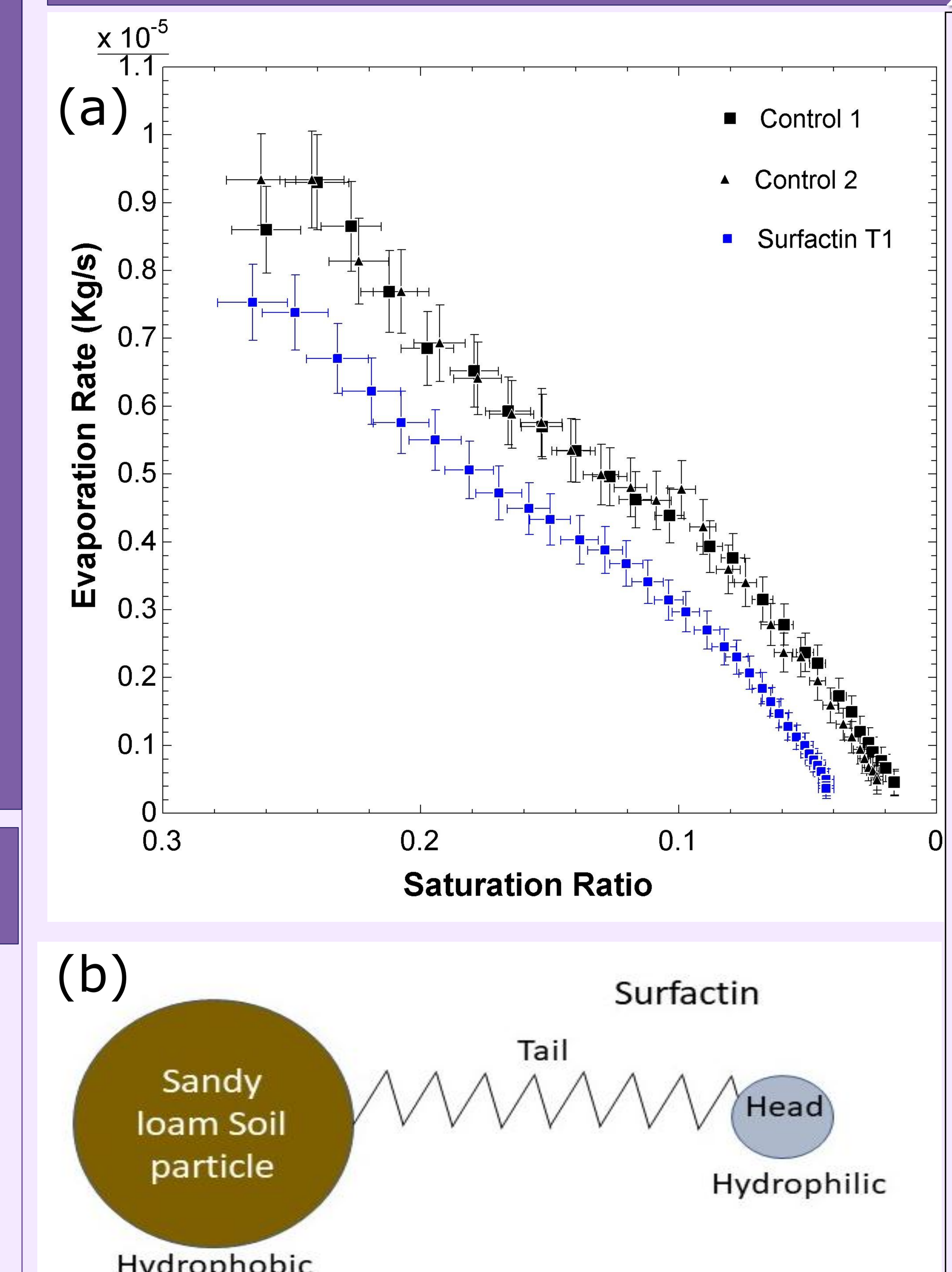


Fig 3. (a) Evaporation rate comparison between control and 3% biochar-treated soil **(b)** SEM image of a biochar

- Biochar treatments reduced evaporation rates during the slow-rate stage (Fig. 1) by disrupting capillary flow to the surface.
- Micro and mesopore structure in biochar (Fig. 2) retained moisture, holding water within the matrix and slowing transport.
- Residual water content nearly doubled in biochar-amended soils compared to controls.

Effect of Surfactin (produced by *B. subtilis*)



- Surfactin-treated soils showed lower evaporation rates across all saturation ratios compared to the control.
- By lowering surface tension, Surfactin weakened capillary rise and limited vertical water transport.
- Its hydrophobic tails bond with soil particles, while hydrophilic heads attract water, enhancing adsorption and retention.

Fig 4. (a) Evaporation rate comparison between control and Surfactin **(b)** Schematic illustration of Surfactin–soil interaction

Conclusions

- Both biochar and Surfactin reduced soil evaporation, improving water-use efficiency in separate trials.
- Biochar retained moisture through micro–mesopores, while Surfactin lowered surface tension and capillarity.
- Each treatment altered evaporation mechanisms differently, yet both enhanced residual water content.
- These findings suggest practical pathways for reducing evaporative losses in sandy loam soils.

Acknowledgment

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