Effect of coal char concentrations on soil bulk density and soil water holding capacity

Resham B. Thapa, Pranav Shrestha***
**School of Energy Resources, University of Wyoming (rthapa@uwyo.edu)*
***Civil and Environmental Engineering Department, University of Maryland*

IECAG 2024 Conference

Introduction

- Coal char(CC) is a porous carbon material produced from the pyrolysis of coal that burns off the volatile matter of coal, leaving behind high carbon containing solid low-density material.
- Coal char shares many properties with biochar such as large surface area, high porosity, low bulk density, and alkaline pH. Biochar reduced soil bulk density as it dilutes weight when mixed with soil (Liu et al., 2012).
- Adding the porous material to soil will have direct effect on soil physical properties.
- We hypothesized that coal char could be a beneficial soil amendment like biochar.
- Use of coal in agricultural sector can potentially explore the non-fuel/environmentally friendly alternative use of coal.

Motivation of the study

- Improvement in soil properties, mimicking the positive effects of biochar.
- long-term carbon sink in the soil, mitigate climate change.

Objectives

- Determine soil bulk density (D_b) on two different soils with different CC concentrations
- Determine the effect of CC concentrations on soil water holding capacity (SWHC) in two different soils.

Materials and Methods

- Greenhouse study performed at the University of Wyoming with completely randomized design (CRD) with 3 replications
- Two soil types: Sandy loam and Sandy clay loam.
- Treatments :
  - ➢ CC concentration by weight (w/w):

  0 (control), 2.5, 5, 10, & 20% CC mixed into the soils and incubated for a month in pots with frequent watering and drying to mimic the real field condition.

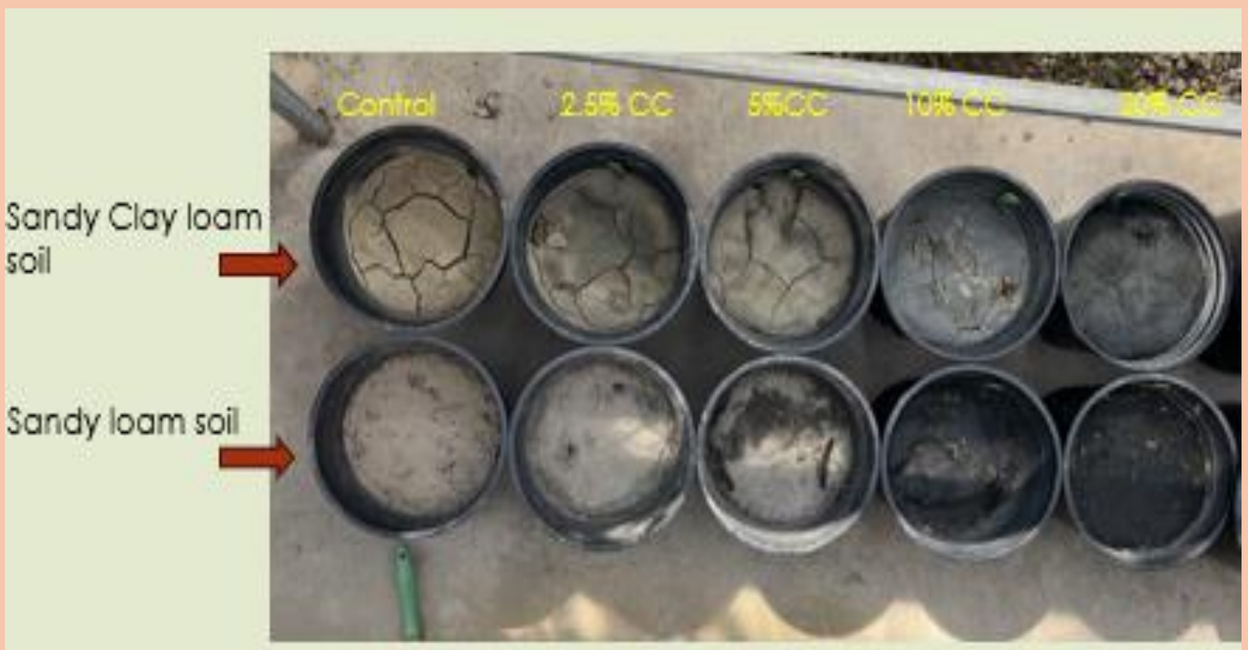


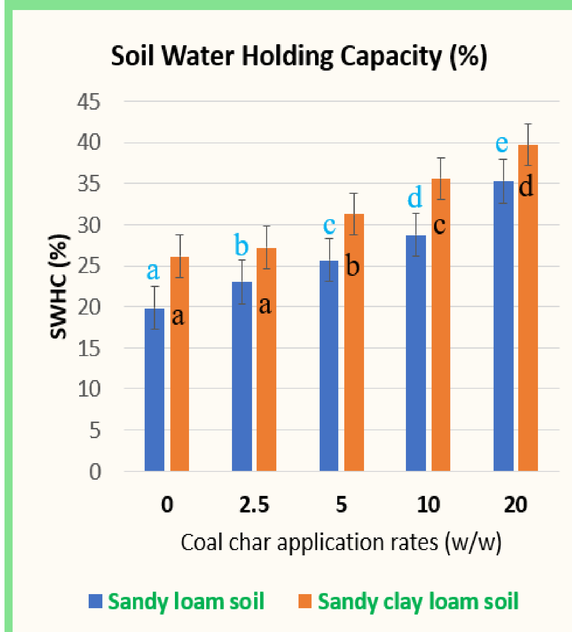
Figure 1. Coal char mixed in two different soils at 0, 2.5, 5,10, and 20 % (w/w) and filled in pots.

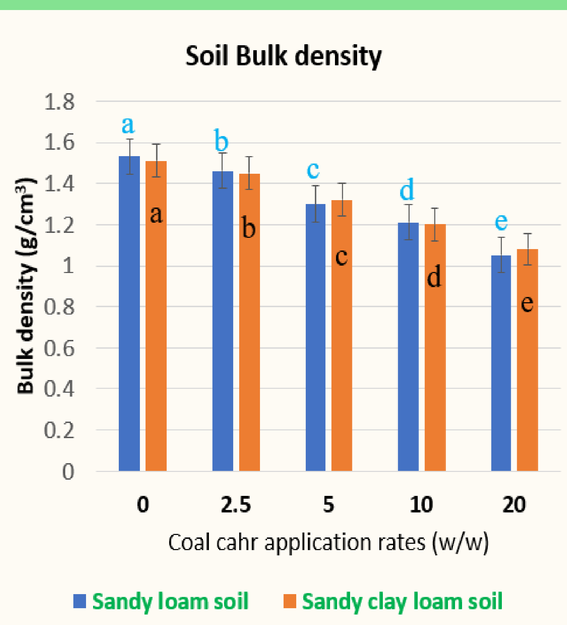
- Soil water holding capacity and Soil bulk density were measured following the methods in Verheijen et al., (2019).

$$Water\ Holding\ Capacity\ (\%) = \frac{(mass\ wet - mass\ dry)}{\text{mass dry}} \times 100\%$$

$$Bulk\ Density = \frac{mass\ of\ soil\ (oven\ dry)}{volume\ of\ soil\ (field\ capacity)}$$

Results and Discussion





Data indicate the mean values (n=3). Means followed by same letter within each column are not statistically significant different at p>0.05

- SWHC on both soils increased significantly at 5% and above CC rates compared to the control (0% CC)
- Soil bulk density on both soils decreased significantly starting at 2.5% and above CC rates compared to the control (0% CC)

Discussion

- Micro pores of CC can have contributed for higher SWHC in both soils.
- CC concentration 2.5% resulted significantly increase on SWHC in sandy loam soil, while in sandy clay loam soil, 5% CC started significant increase.
- Reduced bulk density due to application of CC can have enormous benefits on soil health in long term. High bulk density negatively impact on SWHC, root growth, air and water movement on soil, as a result reduces plant growth and crop yield.

Conclusion

High surface area and greater porosity of coal char could improve soil physical properties.

Acknowledgement
We thank Ryan Pendleton, greenhouse operations coordinator at the LREC, Greenhouse complex, Laramie, WY. The project was supported by the School of Energy Resources (SER), University of Wyoming.

References

- Liu, J., Schulz, H., Brandl, S., Miehtke, H., Huwe, B., & Glaser, B. (2012). Short-term effect of biochar and compost on soil fertility and water status of a Dystric Cambisol in NE Germany under field conditions. *Journal of Plant Nutrition and Soil Science*, *175*(5), 698–707. https://doi.org/10.1002/jpln.201100172
- Verheijen, F. G. A., Zhuravel, A., Silva, F. C., Amaro, A., Ben-Hur, M., & Keizer, J. J. (2019). The influence of biochar particle size and concentration on bulk density and maximum water holding capacity of sandy vs sandy loam soil in a column experiment. *Geoderma*, *347*(August 2018), 194–202. https://doi.org/10.1016/j.geoderma.2019.03.044