The Effect of Biochar With Micropore Size Pores on Increasing Plant Available Water in Sandy Agricultural Soil

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Introduction and Motivation

❑ Soil physical & chemical composition:

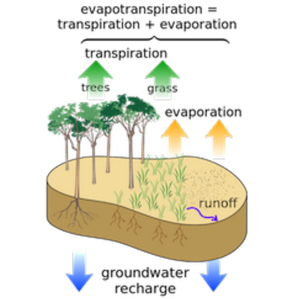
- Most agricultural soils are coarse with low water holding capacity and low organic matter content

❑ Climate:

- High temperature that promote Evapo-trispiration

❑ Water-holding capacity in coarse soil

- drainage of water and nutrients below the root zone making water inaccessible for plants.



Loam: a mixture of clay, sand, and silt

Sand is grainy particle of 2 – 4.75mm

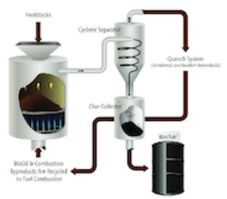
Silt: intermediate size between sand and clay

❑ Biochar

- an organic material produced by the pyrolysis of carbon-based biomass including wood, crop residues
- source and application is dependent on chemical, physical, and environmental factors

❑ Biochar amendment on agricultural soil

- shown to increase water-holding capacity in soil.
- Biochar with 0.5-50 µm pores size can aid in retaining plant available water for a long time 00s to 1,000s of years!



The aim is to analyze 11 published reports identifying biochar source, pore size, and carbon content in relation with soil water holding capacity.

Conditions of the Meta-Analysis

❑ Literature review was conducted of studies that correlated the application of wooden/plant residues sourced biochar on coarse soil with soil water retention.

❑ The criteria for the inclusion of data in this paper:

- Studies that focused on soil texture composition of sand, loamy sand, sandy clay loam and sandy loam.
- Studies that used wooden as well as dry crop residues as biochar feedstock and included the heating temperature during the pyrolysis process.
- Studies that reported the effect of biochar application on water retention properties including FC and WP or AW.
- AW can be calculated as follows
- *AW=FC-WP.*

Results of the Meta-Analysis

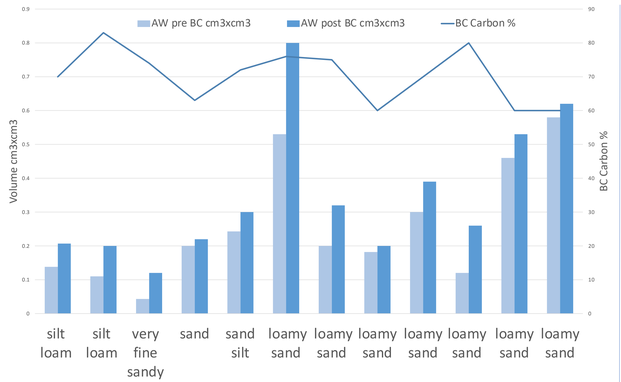


Figure 1: The increases in available water for plants with the addition of biochar on multiple soils and its relation with biochar

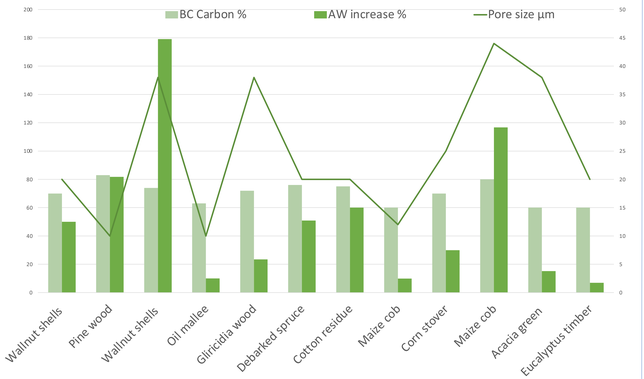
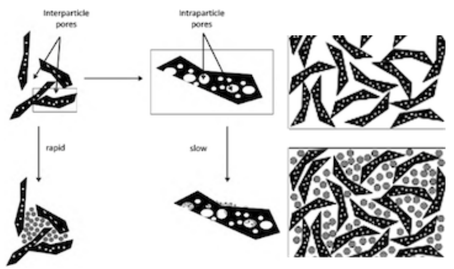


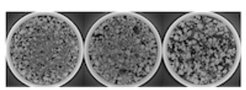
Figure 2: Biochar source applied on soils and biochar pore size in relation with AW increase and biochar carbon content.

- biochar amendment generally improved the soil water holding capacity due to the modification of soil structural properties
- Biochar's improvement of soil water properties depends on soil texture, biochar source and its interaction with soil particles
- Biochar has a direct effect on soil water storage and mobility, it increases the number of pores and consequently the total soil porosity leading to an increase in soil water holding capacity

Hold Water in a Form That is Accessible to Plants

- Nanometer-scale pores do not hold water in a form that is accessible to plants.
- Intraparticle pores in the 0.1–50µm size range are critical for increasing plant available water





- Soft sand and loamy soil treated with the same biochar displayed different AW elevation percentage due to the difference in aggregates formation in the soil
- Finer particle size in coarse-textured soil has more surface area and with the application of biochar with micro pore size, new smaller pore spaces become available to hold water

Conclusion

This comparative analysis of the available literature:
Assessed the application effect of biochar with different properties on the most important soil hydraulic parameter, water availability for plants. The results showed that application of biochar with high micropore number and Micro pore size in the range of 0.5 to 50 µm significantly increases plant available water which determines water holding capacity in a form that is accessible to plants in coarse textured soils.

Future Steps

- How does biochar aging affect water holding capacity in coarse soil?
- What is the optimum application rate of biochar in coarse soil?
- How Biochar application can affect tree farms?
- Develop a decision support tool predicting the impact of biochar additions on soil AW

Acknowledgments

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