Evaluating the Hydrological Characteristics of Different Biochar and its Influence on Soil Water Dynamic

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Introduction

- The aim to enhance soil productivity and eco-system services by incorporating waste-derived biochar has been viewed as an ecological pathway toward sustainable food production.
- One important hypothesized effect of biochar addition to soil is its potential to increase water retention capacity.
- One of the mechanisms for this effect is that biochar provides very large wettable surface area that increases the affinity of biochar treated soils to water.
- Over the long the run, elevated moisture retention promotes biological activity that would lead to biophysical aggregation of soil and subsequent development of soil structure that promotes both infiltration and water storage.
- Physical characteristics of biochar, e.g. porosity and wettable surface area, are key features to understand it sorption capacity and potential effect on soil hydraulic properties.

Purpose

- Soil water status has been recognized as one of the most important abiotic factors controlling soil productivity. Thus, insight of biochar-soil-water dynamic can extend our knowledge of biochar potential to alleviate adverse environmental conditions.

Methods

- **7 Biochar (350 °C)**
- Almond Shell (AS-1 & 2), Walnut Shell (WS-1 & 2), Almond Tree Chip (ATC-1 & 2), Butte College Walnut (BCW).
- **1X- Mobile Unit & WP4C Dewpoint Pentiometer.**

- **Experiment 1: Biochar WRC.**
- **Experiment 2: Biochar + Soil WRC.**
- **Hydrophobicity Test.**

Results

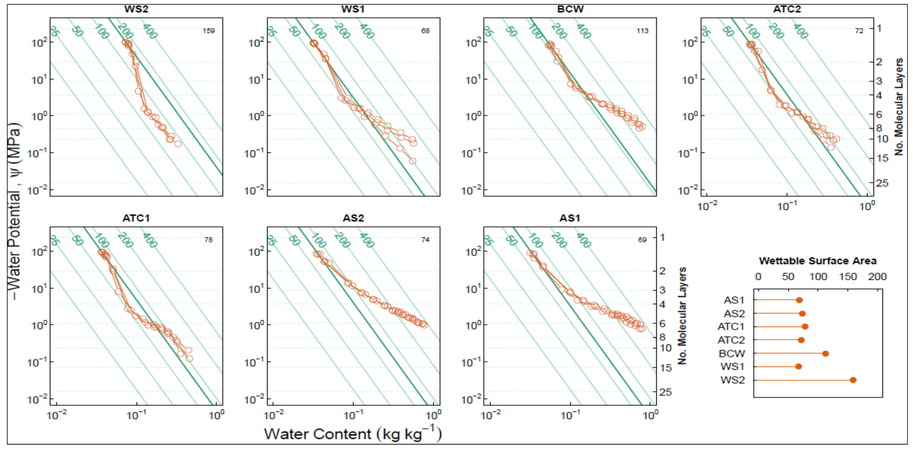


Fig. 1 Wettable Surface Area (WSA)

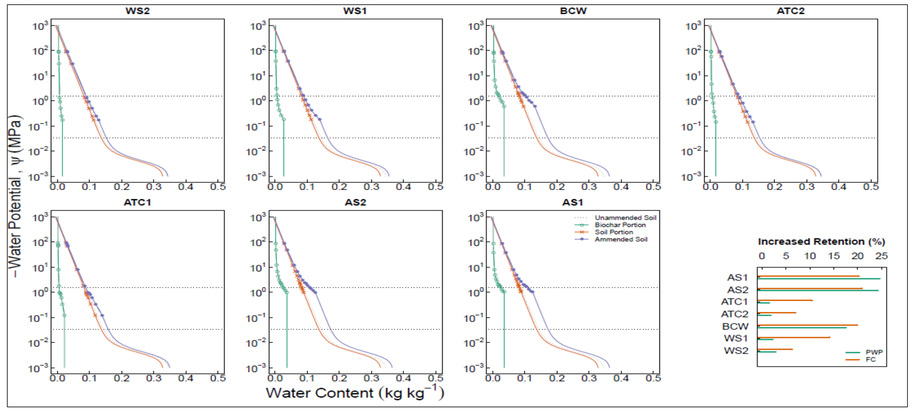
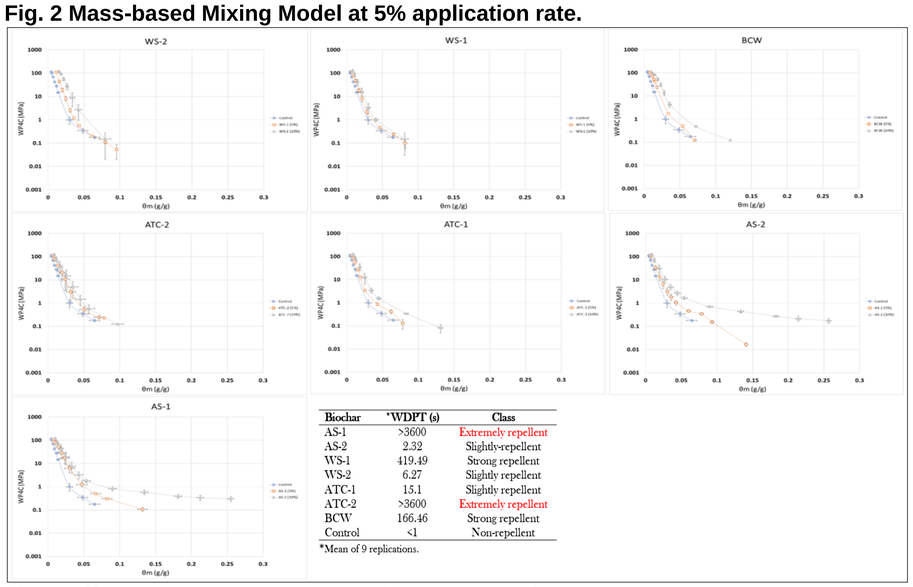


Fig. 2 Mass-based Mixing Model at 5% application rate.



Biochar	*WDPT (s)	Class
AS-1	>3600	Extremely repellent
AS-2	2.32	Slightly-repellent
WS-1	419.49	Strong repellent
WS-2	6.27	Slightly repellent
ATC-1	15.1	Slightly repellent
ATC-2	>3600	Extremely repellent
BCW	166.46	Strong repellent
Control	<1	Non-repellent

*Mean of 9 replications.

Fig. 3 Effect on Atwater Loamy Sand Water Retention at 5 & 10%.

Discussion

- In this study we were able to infer the WSA of different biochar using water vapor measurement and film sorption theory. The film model shows that walnut shell derived biochar (WS-2 and BCW) has the highest WSA (**Fig.1**).
- However, we observed that at 5% & 10% (dry weight) application rates, almond shell biochar has a more remarkable impact on soil water retention (**Figs. 2 & 3**), specifically at the permanent wilting point region for sandy soil.
- Our model predicted as much as 20-25% increase in water holding capacity for almond shell biochar, compared to Control (pure soil). Biochar derived from almond tree chip and walnut shell has negligible effect on soil water retention capacity (**Fig. 2**).
- Change in moisture content at these soil water potential regions can have a profound effect on soil biota (influence overall soil respiration).
- Our results reflect the immediate effect of biochar added to loamy sand soil. Thus, our next research question will address the effect of elevated moisture regime on soil biologically active water potential range. Using both lab incubation experiments in conjunction with mechanistic models, we hope to gauge the overall fates of biochar and its influence on soil CO_2 emission..

Implications

- The results indicate that biochar enhancement of water retention can play a significant role in countering moisture stress in drying coarse-textured soils.
- Encourage the use of locally produced biochar from small-scale pyrolysis units (may be more economically feasibility).
- Ultimately, if adopted, the feedback responses from diverting waste and lessening GHG emissions can improve the livelihood of impacted communities.

Acknowledgements

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