# How Does Biochar Affect the Pore Size Distribution, S-Index and Saturated Hydraulic Conductivity of a Sandy Soil?

HAMZE DOKOOHAKI, FERNANDO MIGUEZ, DAVID A. LAIRD, ROBERT HORTON, AND ANDRES BASSO
IOWA STATE UNIVERSITY- AGRONOMY DEPARTMENT

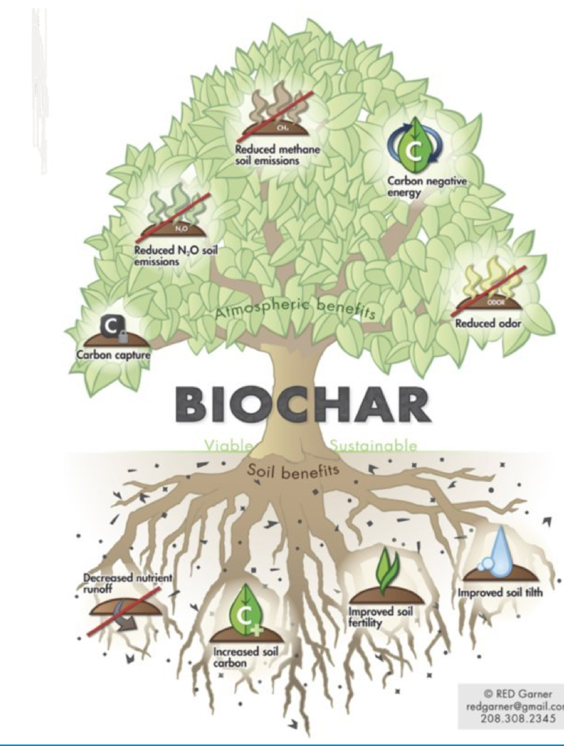
## OBJECTIVES

The main objective of this study is to evaluate the effects of hardwood fast pyrolysis biochar on the hydraulic and physical properties of a sandy soil. This evaluation was done, by assessing changes in :

1. Pore Size Distribution (PSD)
2. Most frequent pore size
3. S-Index
4. Saturated Hydraulic conductivity

## INTRODUCTION

- Crop growth can be highly dependent on soil physical properties, directly and indirectly through their effects on :
  1. Water, aeration,
  2. Temperature,
  3. Penetration resistance.
- Biochar has been shown to improve some soil physical properties such as Bulk density, porosity and water holding capacity.




## MATERIALS & METHODS

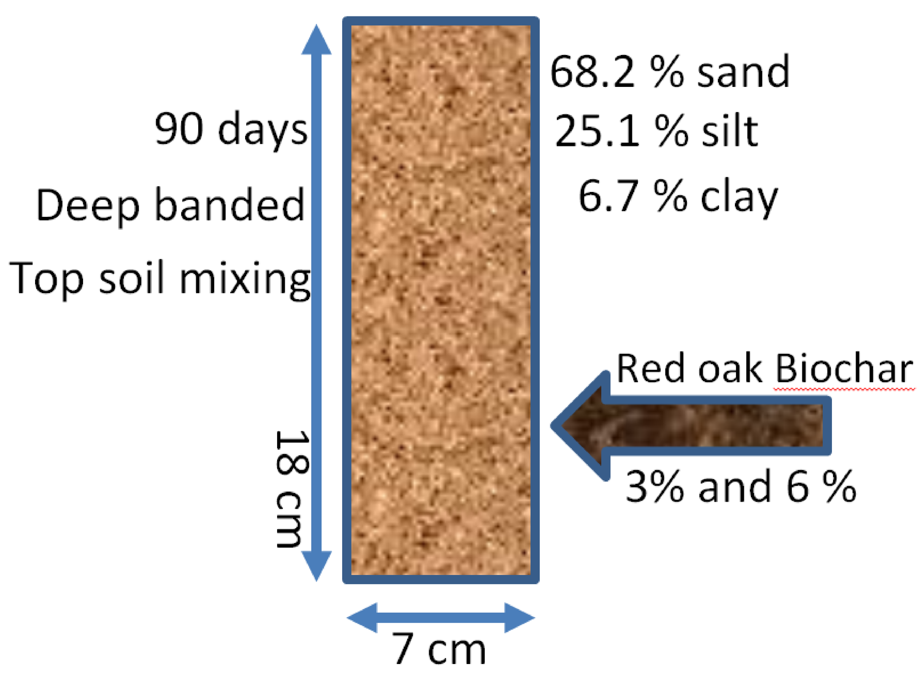



**Figure 1:** Soil Incubation scheme

- Van-Genuchten function was used to estimate parameters of the water retention curves.

$$\theta(\Psi) = \theta_r + \frac{(\theta_s - \theta_r)}{[1 + (\alpha|\Psi|)^n]^{1-\frac{1}{n}}} \quad (1)$$

- The pore size distribution was estimated from the soil water characteristic curve according to the Young Laplace equation.
- Peak of the pore size distribution shows the highest change in soil water content for a specific unit of suction head which corresponds to the most frequent pore size diameter.
- The S-index also was calculated using the following equation (Dexter 2004):

$$S = -n(\theta_s - \theta_r)\left[\frac{2n-1}{n-1}\right]^{\frac{1}{n}-2} \quad (2)$$

- The hydraulic conductivity was also estimated by using the following model (Aschonitis and Antonopoulos (2013)):

$$K_s = 1632.5|S_i|(3.9(\alpha\phi_e))^{(-30.9(\alpha\phi_e))} \quad (3)$$

## RESULTS

### Change in Soil water retention curve

- All biochar treatments have higher $\theta_s$ and steeper slope than the control (Fig. 1).
- As a result of having steeper slope, it is expected to have a higher s-index than control.
- This increases in water content was higher particularly at lower tensions suggesting a significant change in soil structure, proportion and distribution of macropores.

| Treatment | n | $\theta_r$ | $\theta_s$ | $\alpha$ | $D$ | $S$ | $K_s$ |
|---|---|---|---|---|---|---|---|
| - | - | $(\frac{cm^3}{cm^3})$ | $(\frac{cm^3}{cm^3})$ | $\frac{1}{cm}$ | $(\mu m)$ | - | $\frac{cm}{day}$ |
| Control | 1.51 | 0.09 | 0.43 | 0.031 | 201 | 0.081 | 237 |
| UTM 3% | 1.55 | 0.11 | 0.47 | 0.021 | 125 | 0.092 | 226 |
| UTM 6% | 1.45 | 0.10 | 0.50 | 0.032 | 217 | 0.088 | 258 |
| DBR 3% | 1.57 | 0.10 | 0.45 | 0.017 | 99 | 0.092 | 203 |
| DBR 6% | 1.53 | 0.11 | 0.46 | 0.021 | 133 | 0.087 | 218 |

### Change in Pore Size Distribution Curve

- all biochar treatments shift to the left with smaller pore size compared to the control treatment except for UTM6.
- This phenomenon is being considered as major reason for an increase in water content near saturation and field capacity.

### Change in saturated hydrulic conductivity and S-index

- An increase was seen in soil quality index for all biochar treatments compared to control, except for DBR treatment with 6% biochar application.
- Both method and application rate increases the soil quality index.
- Analysis of Ks showed that only for DBR3 treatment had lower Ks, compared to control.
- Our results suggests that DBR method had lower Ks in comparison to the UTM method.

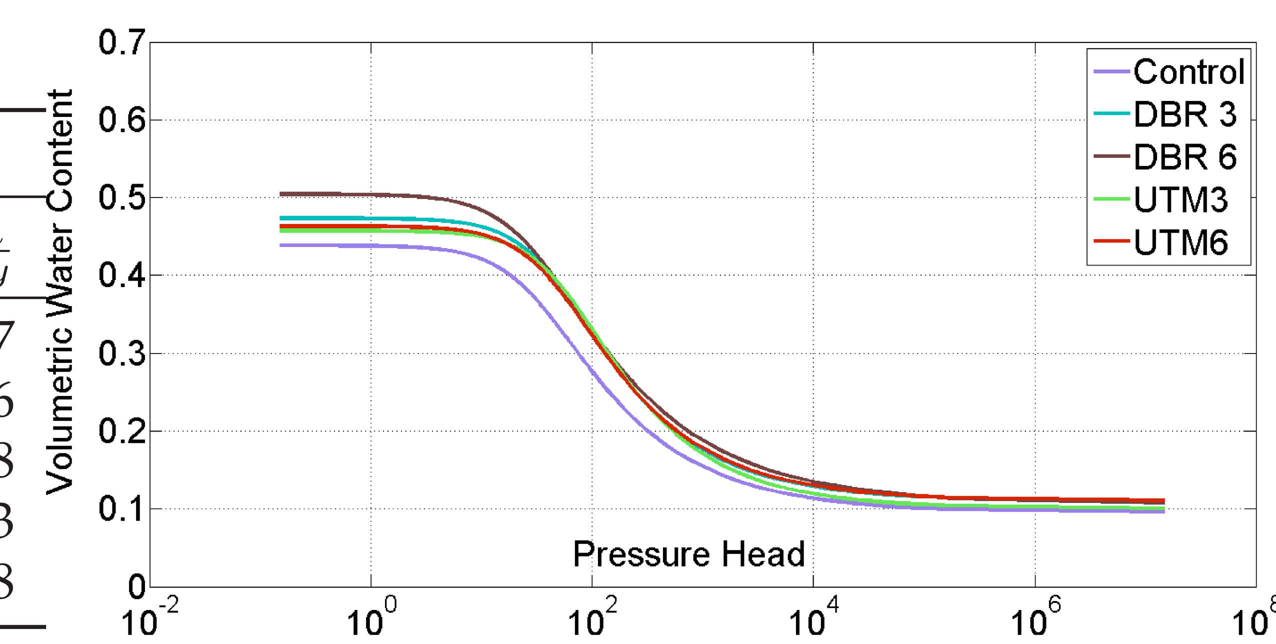



**Figure 2:** Soil water retention curve for different treatments

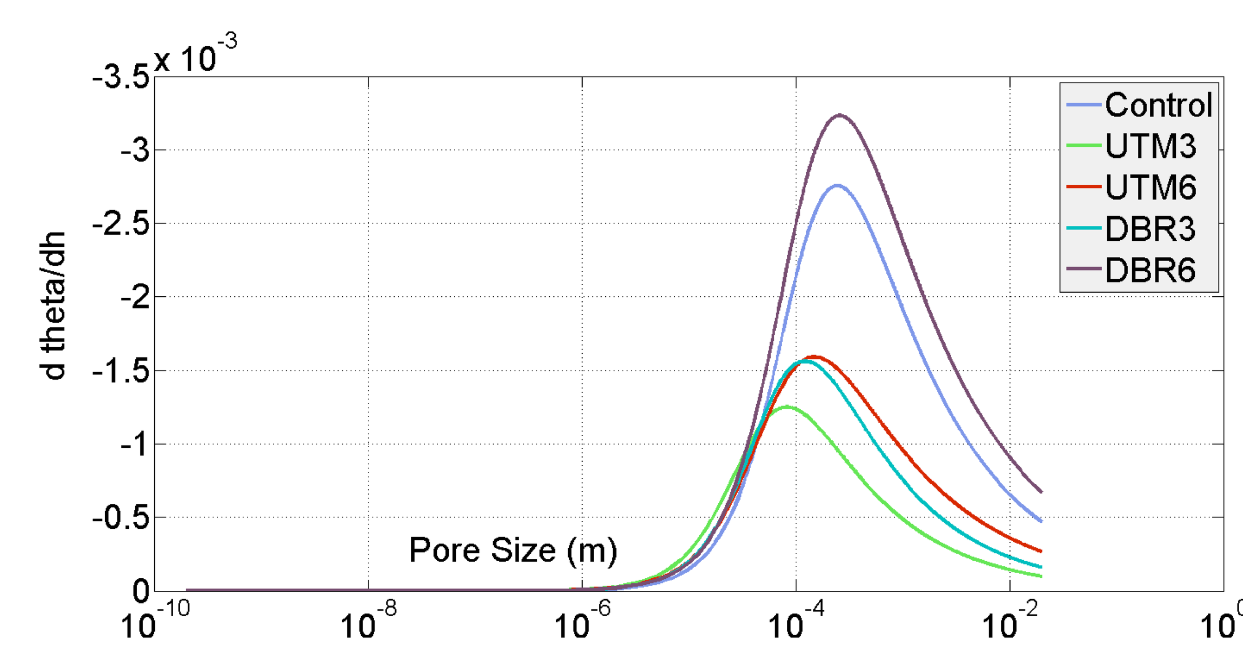



**Figure 3:** Pore size Distribution of different treatments

## REFERENCES

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## CONTACT INFORMATION

**Web** http://para2x.wix.com/home
**Email** hamzed@iastate.edu
**Phone** +1 (785) 317 7675