Preferential Rooting in Biochars

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Introduction

Biochar is an old 'new' technology that has been studied in tropical soils with compelling evidence of its ability to improve overall soil quality and yield through five key effects:

(i) root stimulation,
(ii) changes in soil biogeochemistry,
(iii) altered microbial communities,
(iv) increased presence of adsorbing surfaces, and
(v) potential presence of signaling compound analogues[1] (Figure 1)

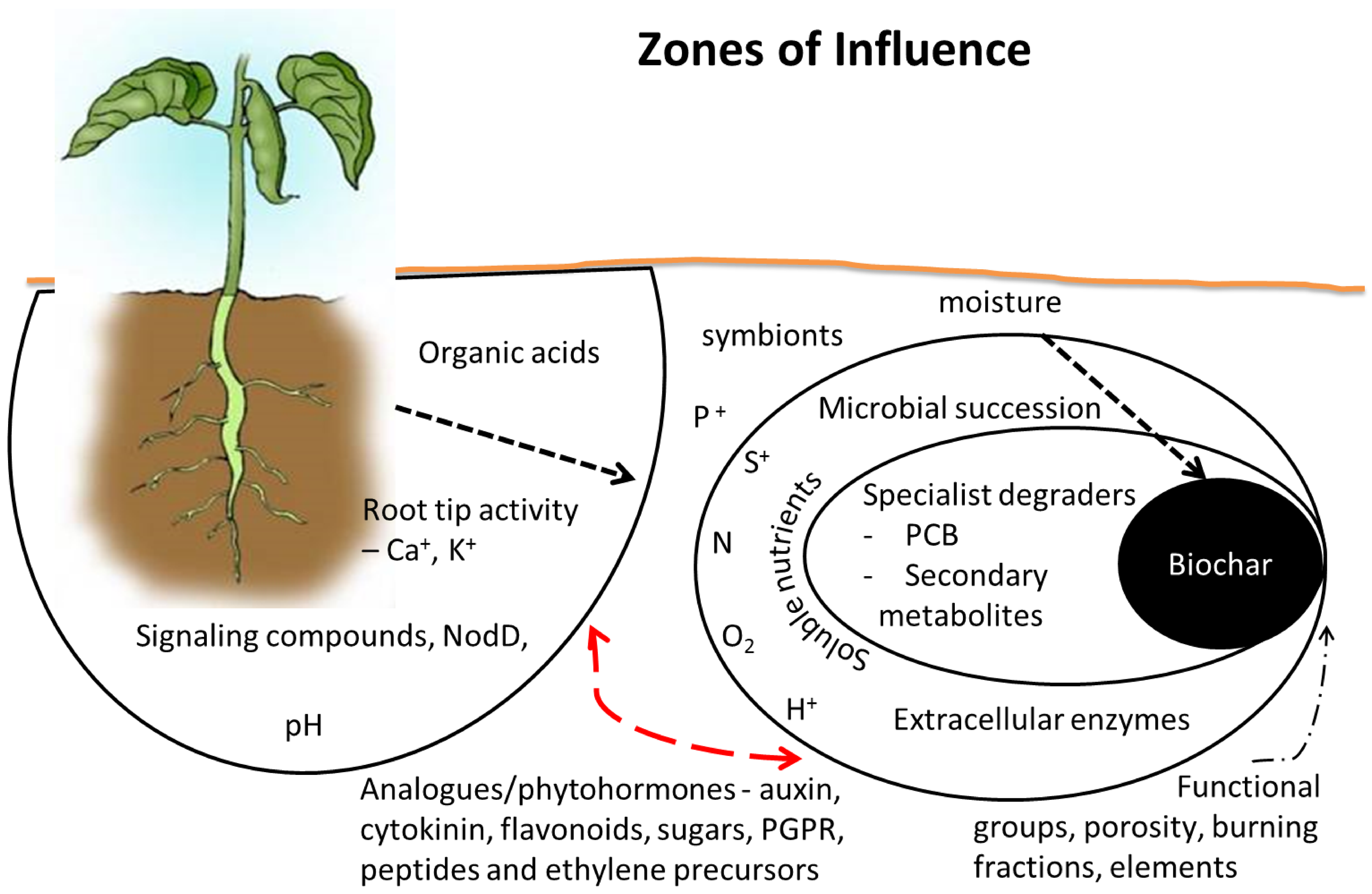

Figure 1. Conceptual illustration of plant-root and biochar interactions (Pulver, 2014)

Beyond these indirect effects, little is known about the mechanisms controlling the interactions between roots and biochar. Elucidating the mechanisms behind the biochar effect on plant-root interactions is difficult and imprecise as biochars are highly variable in their characteristics and affect plants differently under differing environmental conditions.

We are seeking a mechanistic understanding of soybean root interactions by investigating the morphological changes in soybean (*Glycine max* (L) Merrill) root architecture under induced edaphic, hydraulic and competition stresses in the presence of differently prepared biochars applied at varied rates.

Reference
Lehman J., Rillig M.C., Thies J.E., Masiello C.A., Hockaday W.C., Crowley D. (2011). Biochar effects on soil biota – a review. Soil Biology & Biochemistry, 43, 1912–1836.

Methods

Preliminary Experiments

Gasified biochar (1000°C) was mixed with either sand or MiracleGro potting soil at 0, 10, or 20 t ha^{-1}. *Glycine max* (L) Merrill cv. Envy was grown to determine if biochar would stimulate or impede germination in growth chamber experiments (150 µE m^{-2} s^{-1} light conditions 16 h, 80% humidity, 22 ±2°C and at 16 ±3 °C for 14 d). Plants were irrigated using four water treatments consisting of increasing concentrations of Celtic Sea Salts (Selina Naturally, Anden, NC) of 1.5 g L^{-1}, 3.0 g L^{-1}, 4.5 g L^{-1} and 6.0 g L^{-1}.

Results

- Increasing rates of biochar applied:
  - Improved time to germination
  - Increased root to shoot ratios (Fig. 2)
  - Promoted more growth despite high brackish water irrigation

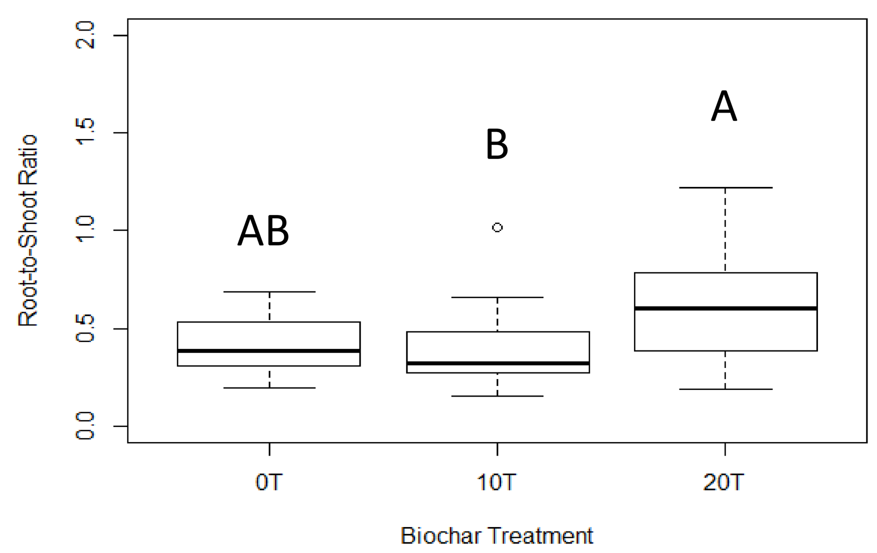

Figure 2. Root to shoot ratios ($p<0.05$)

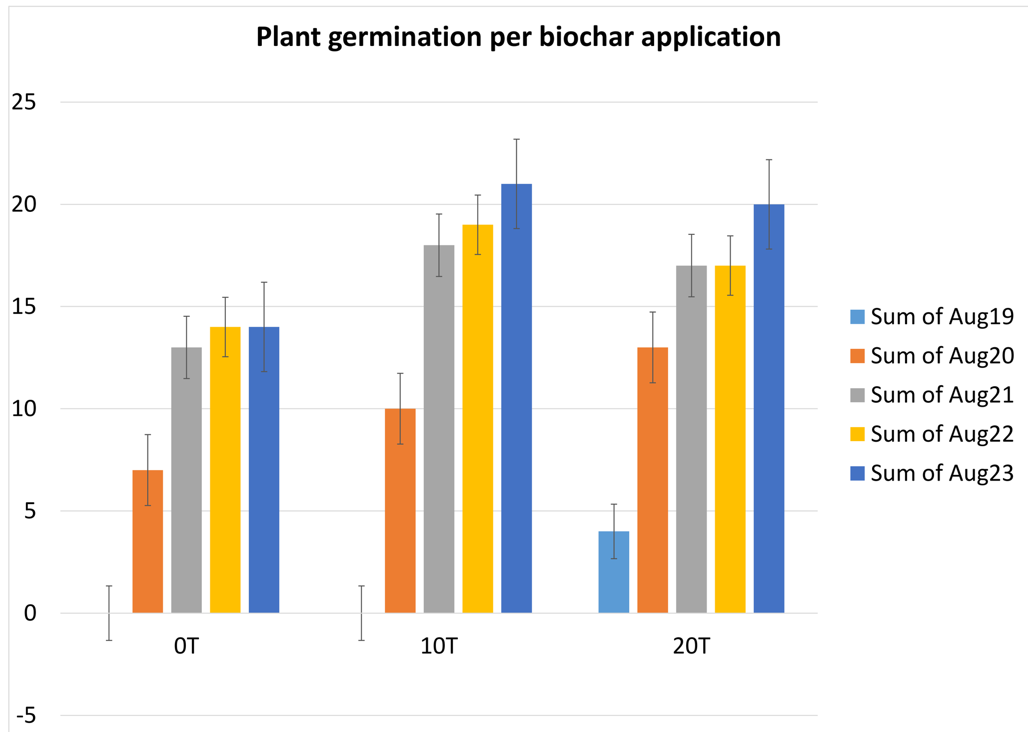

Figure 3. Total plant germination per biochar application across all brackishwater treatments

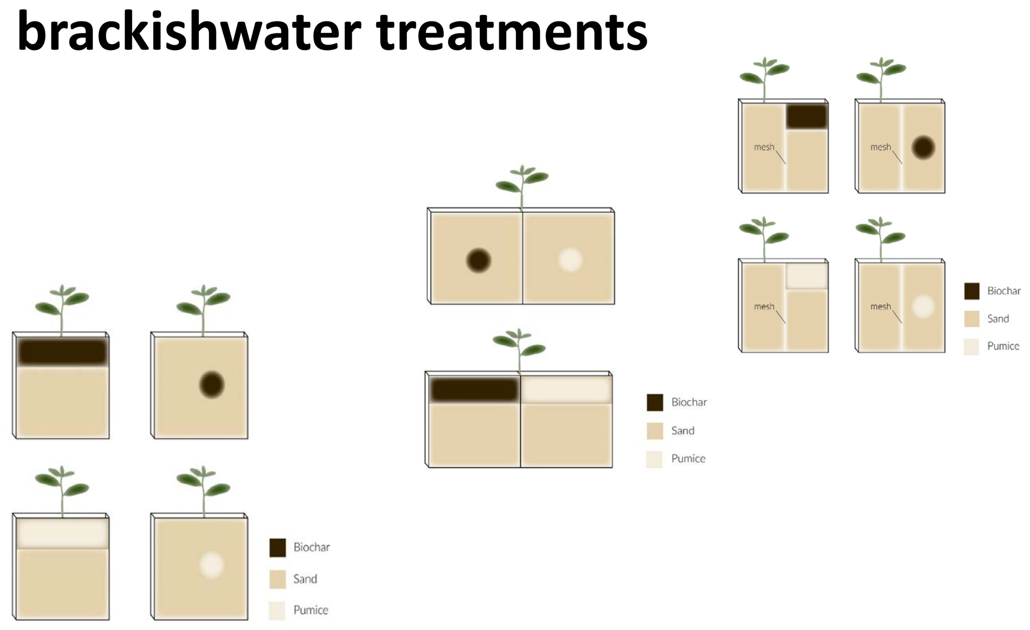

Figure 4. Conceptual designs

Discussion

The biochar used in these experiments was highly alkaline and had below detectable limits of VOCs and dioxin, therefore compounds on biochar surfaces were likely not responsible for observed effects.

High surface area (695 m^{2} g^{-1}), micro-porosities in the range of 1-10 µm and relatively high CEC (331 mmol kg^{-1}) potentially could have improved salt sorption and resulted in better growth.

Without soil flushing, salt accumulation in the micropores would likely reach a threshold where toxicities and deficiencies would be observed.

Ongoing Research

- Grapevine biochars
- 350°C, 450°C, 550°C and 650°C
- ± steam post-treatment
- 0, 5, 10 and 20 t ha^{-1} application rates
- *Glycine max* (L) Merrill cv. Williams 82
- Growth chamber (14 d).
- Stresses (Fig. 4)
  - ± Biochar
  - Nutrient (low phosphorus)
  - Biochar placement
  - Root hair exclusion mesh
  - Split-root design

- Acrylic rhizo-trons
- WinRhizo Software ™
- Vertical Scanners
- Drip irrigation