Can Biochar Enhance Native Soil Carbon Stocks?

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Potential Agroecosystem Benefits Through Biochar

Biochar is often promoted as a panacea for agricultural and environmental problems, but its actual beneficial results may not be realized due to differences in material characteristics, soil properties, and agricultural systems. To date, the mechanisms for providing multiple ecosystem services and the conditions under which they may be realized are poorly understood. In this study, the forestry agroecosystem has been chosen in response to an increasing need to improve sustainable management of forest plantations and new sources of bioenergy.

Research Hypothesis and Objectives

We hypothesize that declines in soil fertility, soil organic carbon stocks, and the effect of reduced species diversity, occurring in conjunction with long-term thinning and removal of understory biomass, can be mitigated through the return of wood feedstock biochar from bioenergy production, while increasing soil C stocks. Thus, the primary objective of this study *is to determine if biochar soil amendments produced by pyrolysis of biomass from forest thinning for bioenergy can maintain, or enhance, the carbon storage in forest soils.* We are using a series of laboratory experiments to examine fundamental physical and chemical processes that occur in response to the application of biochar to soils representative California forest plantations. Ecosystem services being evaluated include soil C storage, nutrient cycling, and, water-retention.

Experimental Approach

- **Produce biochar** from ponderosa pine at 300, 500, 700, and 900 °C using a Thermcraft pyrolysis unit (UC Davis, Department of Biological and Agricultural Engineering, Biomass laboratory).

- **Conduct saturated and unsaturated soil column leaching experiments** (using McCarthy Sandy Loam and acid washed quartz sand) to determine if additions of each the four biochars affect **retention of dissolved organic carbon (DOC)**.

- Use high pressure liquid chromatography with a diode array detector (HPLC-DAD), to **quantify charcoal molecular markers** (benzepolycarboxylic acids -BPCA's) of the leachate and soil from column experiments to differentiate between native and non-native soil carbon pools.

Collect soils and duff

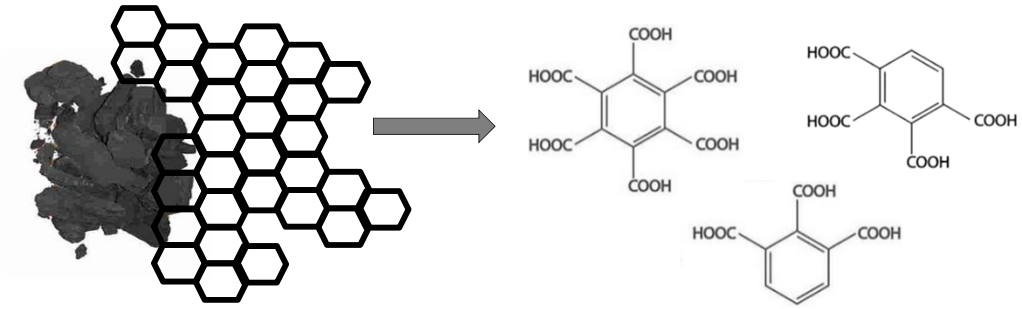
Prepare biochar and duff solution (DOC)

Leach soil columns with duff tea

Quantify DOC and BPCA's

Molecular Markers for Biochar

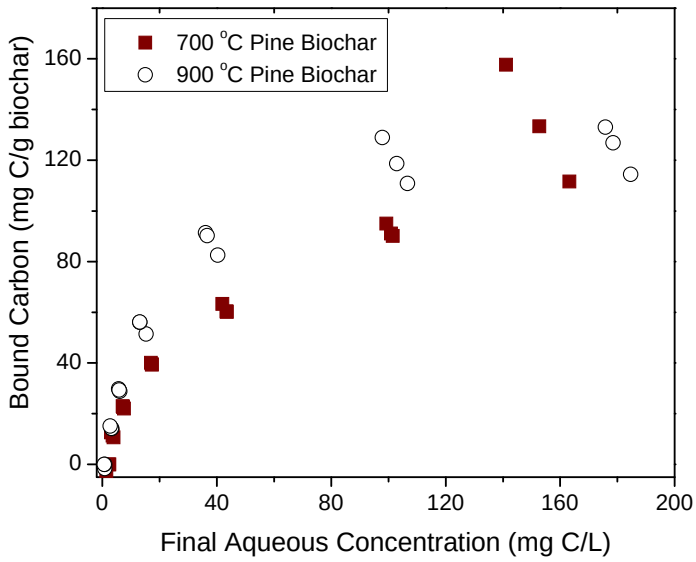
Differences between DOC from duff material (native C) and biochar (non-native C) are being determined using a set of molecular markers (benzenepolycarboxylic acids; BPCA). Initial method development is complete and sample analysis of soils and column effluent solutions is underway.

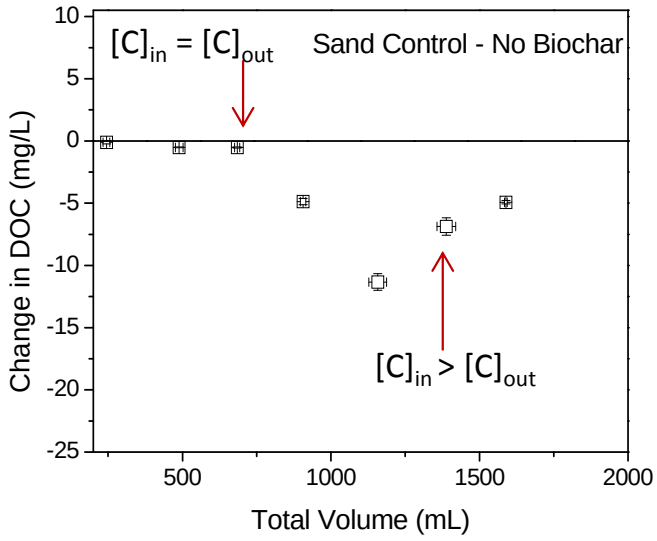


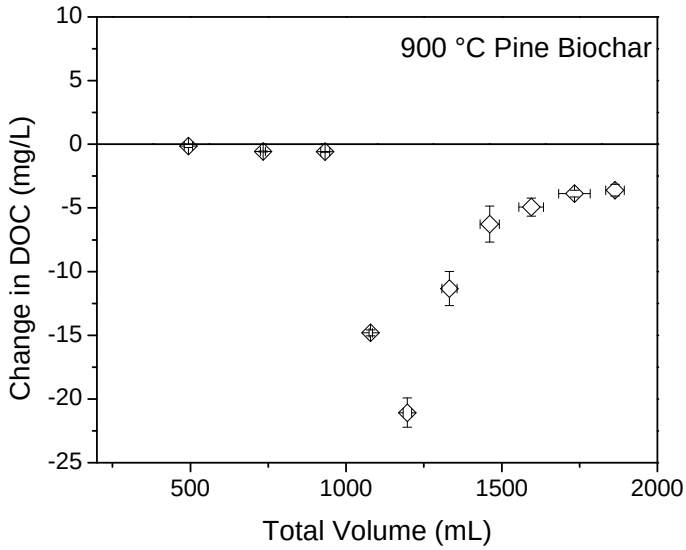
Nitric acid oxidation of aromatic rings in BC form specific molecular markers for charcoal. Image is an example of production of BPCAs from condensed aromatic molecules

Initial Results

- Biochars produces from Ponderosa Pine bind substantial quantities of DOC, with increased sorption with increased pyrolysis temperature.
- Change in DOC in leachate fractions of sand columns, compared to initial concentrations, show increased retention of DOC in columns with addition of 900 °C Pine biochar. Error bars represent the standard error of three replicates.
- Initial data show potential for biochar to be used in course textured soils to retain native soil carbon.







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