Kearney Foundation Fellowship
Final Report Summary - Due October 31, 2010

Fellowship Recipient's Name: Niloufar Ghazal

Project Title: Investigating Dissolved Organic Carbon Uptake to Biochar

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Reporting Period: September 2009-August 2010
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Your report should include the following information:

1. Project objectives and status: (*Include objectives and summary of progress. Show key figures or tables if appropriate).*

2. Describe the major challenges and opportunities or other pertinent information important in the overall achievement of your project.

Investigating Dissolved Organic Carbon Uptake to Biochar

Niloufar Ghazal

Background:

Biochar is charcoal created from biomass. Biochar differs from charcoal in that its primary use is not for fuel. It is made by pyrolysis of biomass at very high temperatures (350-900° C) in the absence of Oxygen. Biochar can have very diverse properties depending on the pyrolysis temperature and the biomass from which it is made. Sources of biomass include nutshells, animal manure, woodchips, and sawdust among others. Recent interest in biochar originates from the discovery of Terra Preta de Indio (Indian Black Earth) soils discovered in Brazil. These soils had charred biomass incorporated into them approximately 2500 years and to this day have higher organic matter content and fertility than adjacent non-amended soils. Recent research indicates many potential benefits of the use of biochar in agriculture some of which include, increased soil fertility and agricultural yields, increased water retention, production of renewable fuels from biomass, and reduction of greenhouse gas emissions (N_2O and CO_2).

Research Objectives:

1. To evaluate the impact of different biochars on carbon absorption
2. To determine if biochars' source material and pyrolysis conditions have potential to effect Carbon and Nitrogen cycling for biochar amendments to soil.

Materials:

Materials used included Compost Tea which is organic compost shaken in Barnstead Nanopure (BNP) water for 24 hours, centrifuged, then filtered through 0.8um filter, 5mM NaCl which served as water and three types of biochar: Walnut Shell (950° C), High Temperature Wood Feedstock (900° C), and Low Temperature Wood Feedstock (700° C). We also tested activated carbon (AC) and kaolinite along with the biochars. Batch experiments (24 h, 8 rpm end-over end mixing, 5 mM NaCl, pH 7) were conducted to measure carbon and nitrogen uptake to the biochars, AC, and kaolinite.

Results:

In each experimental design, the results varied. For carbon sorption, it was found that Walnut Shell (WS) BC and AC bound significantly more carbon than the low temperature (LT) BC, high temperature (HT) BC, and kaolinite (Figure 1a). It was also discovered that the LTBC was unstable and released carbon into solution. For nitrogen sorption, similar trends were observed with highest sorption to the WSBC and AC (Figure 1b). The LTBC was again observed to be unstable in that it released nitrogen into solution. When comparing bound carbon to bound nitrogen, the overall trend was that all materials bound significantly more carbon than nitrogen. However, out of all the materials, the WSBC and the AC bound the most carbon and nitrogen, with preferential sorption of carbon over nitrogen. It was also found that initial concentrations of carbon and nitrogen had an effect on the amount bound. In the case of nitrogen, materials showed a general trend of increasing nitrogen bound with increasing initial concentration of nitrogen. In the case of carbon, the materials showed varying trends. For AC, as the initial concentration of carbon increased, the percentage of carbon bound decreased while the WSBC showed an increase in percent carbon bound as the initial concentration of carbon increased. We also tested whether or not the materials had a preference for binding aromatic compounds. It was observed that all materials preferentially removed aromatic compounds from solution. AC preferentially binds aromatic fractions at low concentrations of carbon and decreases with increased carbon sorption. However, as bound carbon increases further, aromatic fractions are again preferred. WSBC consistently removes a greater portion of the aromatic fraction of DOC than other materials, while all other materials show general trend of decreased preferential binding of aromatics with increased binding of carbon.

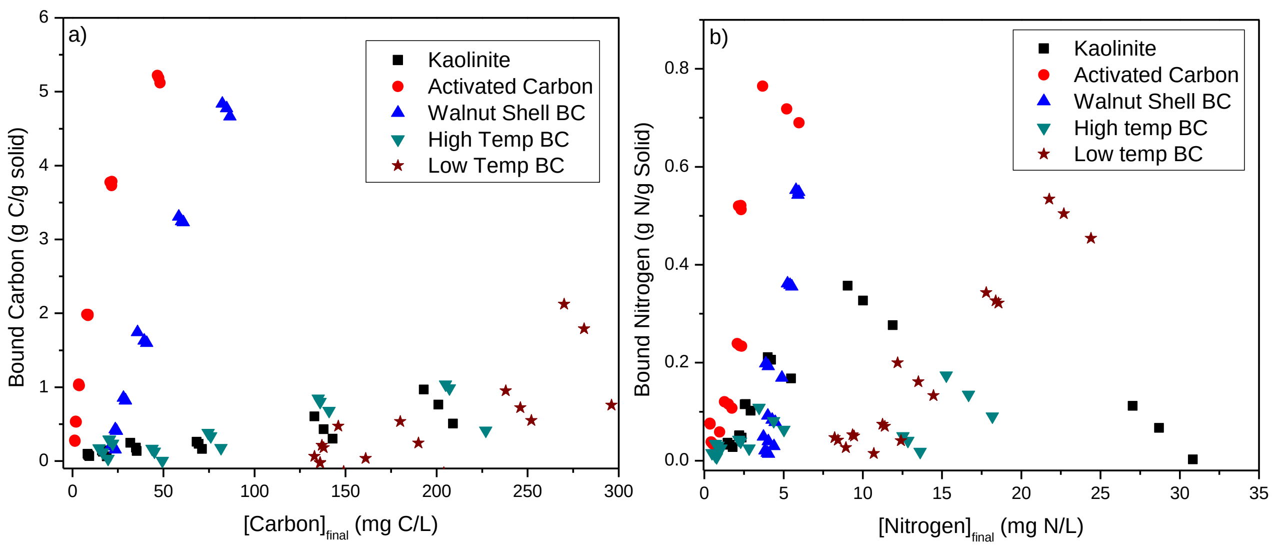

Figure 1. 24 hour Sorption isotherms for a) C and b) N sorption to biochars, activated carbon, and kaolinite (pH 7, 5 mM NaCl).

Conclusions:

The material from which the biochar was made had a significant effect on its ability to bind carbon and nitrogen. The temperature at which the pyrolysis took place had a significant effect on the behavior and properties of the biochar. Due to the hydrophobic nature of biochars they tend to preferentially bind aromatic fractions of DOC. However, as concentrations of DOC increase the sorption of non-aromatic regions of DOC increases. This *suggests* sorption may occur via multiple mechanisms and exceed monolayer coverage. Another reason for the observed results may result from different size fraction of organic matter being removed from solution more favorable with different biochars. These results demonstrate the need to consider biochar source material and pyrolysis method when amending soil to positively impact carbon and nitrogen cycling in agricultural cultivation.