The Effect of Biochar Application Rate on Soil Microbial Community

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http://sunmarkenvironmental.com/bio-char/
Use of biochar as a soil amendment becoming widespread.

Differences in biomass material and or pyrolysis conditions results in differences in biochar produced.

When applied to soils biochar changes soil properties.

However, biochar effect on soil not fully understood.

There is uncertainty of the effect biochar has on biology?
Background

- Biochar shown to improve soil water holding capacity, pore size, nutrient availability, and bulk density (Downie et al., 2009).
- Biochar influences crop growth positively and/or negatively.
- Biochar soil interaction dependent on inherent soil properties (textures, OM content etc).
- This suggests there is room for further research.
Background

- Previous work in our lab observed variation in biochar characteristics when produced from different plant biomass.
- Ongoing research in our lab observed differences in soil microbial community in soils treated with biochar produced from differing biomass material.
- As part of the overall project we are looking at the physical, chemical, and biological implications of applying biochar to soils.
PLFA

- Phospholipid fatty acid (PLFA)
  - Can be used to fingerprint microbial community structure
- Sensitive to management regimes
- Different fatty acids act as bio markers for certain groups of organisms
Hypothesis

- We hypothesize that applying biochar at different rates will alter soil microbial community and function.
Objectives

- To determine the effect of biochar application rate on soil microbial community structure.

- To determine the effect of biochar application rate on extracellular enzyme activity in soils in NW Missouri.
Biochar

- Can be obtained from variety of biomass sources
- Formed by pyrolysis, incomplete burning under low oxygen conditions
- Final product is a function of: Pyrolysis Temperature and Rate as well as biomass origin
Sources of Biomass

- Biomass sources are commonly available materials in Northwest Missouri.
- Biochars properties vary based on material used.
- These are:
  1. Corn Stover
  2. Hardwood
Hardwood

- Carbon content averages <60%
- Nitrogen content averages approximately .6%
- Low nutrient value
- High surface area

Corn Stover

- Carbon content averages <60%
- Nitrogen content averages approximately 0.5-1.2%
- Intermediate nutrient value and surface area

Biochar Production Process

- Biomass placed in steel tins to minimize oxygen
- Start temperature 100°C
- Final temperature 450°C (held for 4 hours)
- Biochar cooled and then pulverized with mortar and pestel
Soil Source

- Soil will be collected from the University Farm to a depth of 15 cm from fields that are under a corn soybean rotation.

- 15 cm will represent approximate limit of tillage.
Soil Preparation Process

- Soils passed through 4mm sieve and analyzed for:
  - Soil pH
  - Soil organic carbon (SOC)
  - Cation Exchange Capacity (CEC)
  - N,P,K soil nutrient status
  - Soil water holding capacity

- Soil placed in jars treated with biochar and incubated for 30 days @ 25C
Experiment Design

- Two biochar types and two rates of application with 3 replicates per treatment. (12 samples)
- Control with no biochar added. (3 replicates)
- Destructive sampling at days: 0, 5, 15, and 30 (4 days)
- Rates: 4% and 8% carbon by weight. i.e. at 0 mg, 40 mg, and 80 mg biochar per gram of oven dried soil.
- Total # of samples = 48
## Biochar Application Rates

<table>
<thead>
<tr>
<th>Biochar</th>
<th>Carbon (%)</th>
<th>Nitrogen (%)</th>
<th>Carbon mg/g soil</th>
<th>Biochar mg/g soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>53.26</td>
<td>0.98</td>
<td>40</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>Hardwood</td>
<td>65.46</td>
<td>1.05</td>
<td>40</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>122</td>
</tr>
</tbody>
</table>
At each sampling date samples were frozen at –20°C

- Analyzed for PLFA profiles
  - Lipids extracted from samples using Bligh and Dyer reagent and citrate buffer
  - Phospholipids separated using silicic acid columns
  - The phospholipids are then converted to their methyl-esters by alkaline methanolysis
  - The PLFA data analysis is in progress
Next Step

- Cold water soluble carbon and nitrogen
- Hot water soluble carbon and nitrogen
- Acid soluble carbon and nitrogen
- ICP-OES analysis (Ca, Mg, K, P)
- Enzyme assays
Acknowledgment

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Questions?