Impact of Biochar on Soil Microbial Diversity

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Our premise is that biochar technology, besides its promoted value for C sequestration, needs to be investigated relative to its influence on soil microbial communities.
Applications of biochar have been shown to improve soil physical qualities such as water holding capacity, pore size, nutrient availability, and bulk density (Downie et al., 2009).

Background
Greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxides (N₂O) are of major concern because of their potential impact on atmospheric temperatures.

Soil microorganisms are important regulators and consumers of atmospheric greenhouse gases and consequently aerobic soils can act as either a source or sink for atmospheric CO₂, CH₄ and N₂O.

Since large areas of terrestrial systems are under agricultural production, management effects could be significant for mitigating elevated greenhouse gas concentration in the atmosphere.

Biochar is showing promise to enhance C stabilization in soils. However, the role of biochar and the interacting effect of tillage on soil microbial community and their function have received limited attention and studies have had mixed results.

Background
<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Microorganisms</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxy PLFA</td>
<td>Gram Negative bacteria</td>
<td>Rajendran et al (1997)</td>
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<tr>
<td>Monosaturated PLFA and Cyclic PLFA</td>
<td>Gram negative bacteria</td>
<td>Wilkinson (1998)</td>
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<tr>
<td>16:1w5c,18:3w6c, 20:3w6c,20:4w6c</td>
<td>Arbuscular Mycorrhizaes</td>
<td>Zelles (1999)</td>
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<tr>
<td>18:2w6,9c</td>
<td>Fungi</td>
<td>Olsson (1999)</td>
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<tr>
<td>Branched fatty acids</td>
<td>Gram-positive bacteria</td>
<td>Federle (1986)</td>
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We hypothesize that treatment of soils with biochar will cause a shift in soil microbial communities in soils.
Our objective is to determine changes in microbial community profile at different types of biochar.

Objective
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

Biochar
PLFA Analysis: The soil microbial community will be profiled using PLFA analysis at each soil sampling date.

This will give us a general picture of the broad distribution of microbial groups (e.g. total fungal, bacteria, Gr+ and Gr- bacteria, actinomycetes.)

To substantiate or refute these hypotheses, a series of lab incubation experiments will be undertaken.

Materials and Methods
Agilent 6890GC
Our biomass sources are four commonly available materials in Northwest Missouri that will produce biochars with a high variability of properties. These are:

1. Corn Stover
2. Hardwood
3. Horse Manure
4. Miscanthus

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

Hardwood

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

Corn Stover

- Average carbon content of <40%
- Average nitrogen content of <2%
- High nutrient content low surface area

Horse Manure

http://en.wikipedia.org/wiki/Manure
Miscanthus

- Average carbon content <73%
- Average nitrogen content <0.4%
- Average pH 9.95
- Low bulk density, high water holding capacity

Biomass placed in steel tins and gradually heated to 200C to 450C

This temperature is maintained for 4 hrs

Biochar is allowed to cool

Biochar is extracted from tins and pulverized with mortar and pestle

Biochar Production Process
Muffle Furnace
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 Source
Soils transported to lab in coolers to minimize any affect ambient temperatures may have on below surface soil conditions

Passed through 4mm sieve

Immediately analyzed for:
- Soil pH
- Soil organic carbon (SOC)
- Cation Exchange Capacity (CEC)
- N,P,K soil nutrient status
- Soil water holding capacity
30 day incubation study
- Biochar from 4 different parent materials
- 4% carbon by weight
- Destructive sampling day 0, 5, 10, 20, 30

Experiment Parameters
Results

Gram Negative

Gram Positive
Monounsaturated Fatty Acid

MUFA

- MUFA mol %
- Days of Incubation

Methyl

- Methyl mol %
- Biochar Treatments

[Graphs showing MUFA and Methyl mol % for different biochar treatments over days of incubation.]
Biochar application caused a change in PLFA concentration over time

- Generally, the PLFA concentration decreased during the middle of the incubation period then increased as the incubation progressed
- For this study, biochar type did not appear to significantly affect PLFA concentration

Conclusion
Questions