MIDWEST BIOCHAR CONFERENCE

August 8, 2014 - Champaign, Illinois

Illinois Biochar Group

ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE

USDA

2014 Midwest Biochar Conference
August 8, 2014

Hoosiers and Hawkeyes Rooms
Hilton Garden Inn
Champaign, Illinois

ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE

AGENDA

Friday, August 8

7:30 a.m.	Registration – outside the Hoosiers and Hawkeyes Rooms
7:45 a.m.	Tour of ISTC Laboratories – meet at the Registration Table
7:30 - 8:30 a.m.	Continental Breakfast – Hoosiers and Hawkeyes Rooms
8:30 a.m.	Welcome – Hoosiers and Hawkeyes Rooms
8:40 a.m.	Keynote Speaker
9:25 a.m.	Oral Presentations
10:05 a.m.	Networking Break
10:30 a.m.	Oral Presentations
11:50 a.m.	Lunch and Networking – Hoosiers and Hawkeyes Rooms
12:45 p.m.	Tour of ISTC Laboratories – meet at the Registration Table
1:35 p.m.	Oral Presentations resume
2:55 p.m.	Networking Break
3:20 p.m.	Oral Presentations resume
4:10 p.m.	Open Floor – Questions and Discussion
4:30 p.m.	Closing Remarks

Reception and Poster Session

4:30 - 6:00 p.m.	Reception in the Hoosiers and Hawkeyes Rooms with a poster session from 4:30 to 5:30 p.m.

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7:30 - 8:30 a.m.	**Continental Breakfast** – Hoosiers and Hawkeyes Rooms

Hoosiers and Hawkeyes Rooms

8:30 a.m.	**Welcome:** Steve Peterson - Research Chemist, USDA-ARS, Peoria, IL & Coordinator of IBG; Nancy Holm - Assistant Director, ISTC; and Kurt Spokas - Research Soil Scientist, USDA-ARS, St. Paul, MN;
8:40 a.m.	**Keynote Speaker:** Janice Thies - Associate Professor, Department of Crop and Soil Sciences, Cornell University; Title: *Soil Biological Responses to Biochar Amendments*

Morning Session

Moderator: Nancy Holm

9:25 a.m.	Jim Doten	Emerald Ash Borer: Public Health, the Urban Canopy and Biochar
9:45 a.m.	Kurt Spokas	Biochar Degradation in Soils: The Overlooked Processes
10:05 a.m.	**Networking Break**	
10:30 a.m.	Kathleen Hall	Effect of Biochar on the Fate and Behavior of Allelochemicals in Soil
10:50 a.m.	Wei Zheng	Improving Carbon Sequestration of Biochar through Biomass Chemical Modification
11:10 a.m.	Ryan Anderson	Building the Market for Biochar Through Greenhouse Gas and Water Quality Incentive Programs
11:30 a.m.	Steve Peterson	Comparing Properties of Pennycress and Lesquerella Presscake Biochars
11:50 a.m.	**Lunch and Networking**	
12:45 p.m.	**Tour of ISTC Laboratory** – meet at the Registration Table	

Afternoon Session

1:35 p.m.	Krishna Reddy	Evaluation of Biochar as a Potential Filter Media for the Removal of Mixed Contaminants from Urban Stormwater Runoff
1:55 p.m.	Martha Vaughan	Effect of Soil Biochar Amendment on Wheat Resistance to Fusarium Head Blight and Mycotoxin Contamination
2:15 p.m.	Edward Colosky	A Survey of Biochars: Interactions with Dissolved Ammonia, Nitrate, and Phosphate
2:35 p.m.	Eve Pytel	Urban Wood as a Source for Biochar

2:55 p.m.	**Networking Break**	
3:20 p.m.	Paul Anderson	Increasing Biochar Production with Micro- and Mini-Sized Methods and Devices
3:40 p.m.	John Kelly	Impacts of Biochar Amendments on Soil Microbial Community Activity and Structure
4:00 p.m.	Kurt Spokas	Future Directions for Biochar
4:10 p.m.	**Open Floor – Questions and Discussion**	
4:30 p.m.	**Closing Remarks**	

Reception and Poster Session

4:30 - 6:00 p.m. **Reception in the Hoosiers and Hawkeyes Rooms with a poster session from 4:30 to 5:30 p.m.**

ABSTRACTS

Keynote Speaker

Janice Thies - Associate Professor, Department of Crop and Soil Sciences, Cornell University; Janice.thies@cornell.edu.

Soil Biological Responses to Biochar Amendments

Responses of the soil biota to biochar amendments are characterized by high variability. Soil enzyme activities, carbon turnover, nitrogen cycling and availability, greenhouse gas emissions, microbial abundance and diversity have all been reported to increase, decrease or remain unchanged in biochar amended soils. The major drivers of this variability are biochar feedstock and its production conditions, soil type, climate, land use history, soil management, the crops grown and time since biochar was applied. Feedstock and production conditions dictate the quantity and quality of fixed carbon, ash and bio-oils adhering to the biochar surface. Soil type determines the presence and activity of clays and, together with climate, land use, soil management and crops grown, controls soil pH and Eh, the presence of other organic matter, and resulting water and nutrient availability. All of these factors, which also change over time, interact to influence the behavior of the soil microbial community. Synthesis of the diverse findings remains hampered by a lack of standards against which to compare the effects of different biochars on the soil biota in different settings. Thus, our ability to predict how microbial community will respond to biochar amendments in any given setting and what the resulting impacts on crop productivity and environmental quality will be remains somewhat rudimentary. While results reported may seem like a “dog’s breakfast”, some common themes are beginning to emerge.

Morning Session

Jim Doten – Supervisor Environmental Services at the Minneapolis Public Health in Minneapolis, MN; jim.doten@minneapolismn.gov.

Emerald Ash Borer: Public Health, the Urban Canopy and Biochar

The Emerald Ash Borer (EAB) can devastate the ash population in an urban canopy within six years of detection. Trees play an important role in urban air quality by reducing ozone and particulate matter. The loss of these services results in increased human mortality. Between 2002 and 2007 EAB-infected counties experienced 23.5 additional deaths per 100,000 adults from cardiovascular disease and respiratory-related mortality. The City of Minneapolis, Shakopee Mdewakanton Sioux Community, Minneapolis Park and Recreation Board, and the University of Minnesota have teamed to study the potential role of biochar in restoring lost ecological services. The University of Minnesota developed a study using different ratios of biochar/compost soil amendment treatments on 600 replacement trees. The study will evaluate the effect on tree mortality and vigor over a five-year period. The goal is to speed the replacement of ecological services and minimize EAB public health effects.

Kurt Spokas – Research Soil Scientist at the USDA-ARS in St. Paul, MN; kurt.spokas@ars.usda.gov.

Biochar Degradation in Soils: The Overlooked Processes

Recent data collected from both artificially and naturally weathered biochars suggest that a potential significant pathway of biochar disappearance is through physical breakdown of the biochar structure. Through scanning electron microscopy (SEM), we characterized this physical weathering which increased the spacing between the graphite sheets due to the expansion accompanying water sorption and freeze-thaw, as well as desiccation and rewetting. As these sheets expand (exfoliate) this further accelerates physical break-down of the biochar. The micro- and nano-scale biochar particles resulting from this physical disintegration are still carbon-rich particles with no detectable alteration in the O:C ratio of the carbon structure, but are now easily suspended and moved by infiltration. There is a need to understand how to produce a biochar that is resistant to physical degradation in order to maximize the long-term C-sequestration potential of biochar in the soil system.

Kathleen Hall – Graduate Student at the University of Minnesota in St. Paul, MN; hall0995@umn.edu.

Effect of Biochar on the Fate and Behavior of Allelochemicals in Soil

Before using biochar as a soil amendment, it is important to understand its effect on soil bioavailability of allelochemicals, specifically phenolic acids. This study examines sorption of 14C-labeled ferulic acid, syringic acid, and chlorocatechol to four biochars prepared from individual feedstocks and four "customized" biochars produced from mixed feedstocks using batch equilibration. Pure feedstock biochar sorption order was: switchgrass< swine solids < poultry litter < pine chip for both ferulic (Kd = 1.4-75 L kg-1) and syringic acid (Kd = 0.07-6.03 L kg-1). Both biochar properties and chemical structure appeared to influence sorption. Sorptive properties of biochars produced from combined feedstocks could not be predicted from their pure feedstock components; sorption coefficients were both higher and lower than individual parent materials' biochars. All biochar Kd values, except pine chip, were consistently lower than the reference silt loam soil, therefore incorporating these biochars would not likely alter bioavailability of phenolic acids in this soil.

Wei Zheng – Senior Research Scientist/Adjunct Faculty at the Illinois Sustaianble Technology Center, a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign; weizheng@illinois.edu.

Improving Carbon Sequestration of Biochar through Biomass Chemical Modification

Biochar is being actively explored as a tool for long-term carbon sequestration in soil. In this study, several P-containing substances were added into biomass to produce modified biochars. We found that the TSP chemical fertilizer as an additive could significantly increase carbon retention during biochar production. Compared to unmodified biochar with 50% carbon content, more than 75% carbon would remain in the modified biochar generated from switchgrass mixed with TSP. The thermo-gravimetric analysis showed that the oxidative stability of the modified biochar was significantly enhanced, suggesting that it is very recalcitrant to chemical degradation. A soil incubation experiment was conducted to determine biochar microbial stability in soil. The emissions of CO_2 from the soils amended with the modified and unmodified biochars were very little with no discernible difference. These results indicate that both biochars are stable in soils and the TSP additive has no effects on biochar decomposition.

Ryan Anderson – Ecological Economist at the Delta Institute in Chicago, IL; randerson@delta-institute.org.

Building the Market for Biochar Through Greenhouse Gas and Water Quality Incentive Programs

After several years of development, the American Carbon Registry has released its draft Methodology for Emissions Reductions from Biochar Projects (expected to be finalized summer 2014) to quantify and credit avoided emissions from biomass combustion/decomposition as well as long-term increases in soil carbon sequestration. Credits from verified projects can then be transacted on the voluntary market, creating a new revenue stream for both pyrolysis operators and landowners. This presentation will provide an overview of the new methodology and emerging opportunities for implementation in the Midwest, particularly around row crop agriculture and urban forestry. The session will also explore connections to state and regional water quality initiatives, which may create additional credit opportunities for agricultural projects that reduce nutrient runoff.

Steve Peterson – Research Chemist at the USDA - ARS, Peoria, IL; Steve.Peterson@ars.usda.gov.
Comparing Properties of Pennycress and Lesquerella Presscake Biochars
Presscake is the term for the solid biomass left behind after the oil has been pressed out and extracted from an oilseed crop. In this study, two different oilseed feedstocks, pennycress and lesquerella, were examined as source material to prepare biochar for horticultural applications via gasification. In addition to comparing the two feedstocks (pennycress and lesquerella), we compared the biochar processing methods by running each feedstock in three slightly different TLUD gasifier designs as well as a retort furnace system with controlled temperature. Lesquerella biochar, produced by retort furnace at 500 and 600 °C, resulted in an unusually monodisperse pore size of approximately 2 nm; future work to potentially take advantage of this result will also be discussed.

<u>Afternoon Session</u>
Krishna Reddy – Professor at the University of Illinois at Chicago; kreddy@uic.edu.
Evaluation of Biochar as a Potential Filter Media for the Removal of Mixed Contaminants from Urban Stormwater Runoff
Urban stormwater runoff can carry a wide range of contaminants, many of which exceed federal maximum contaminant levels, into surface water resources (e.g., rivers and lakes). The use of filtration systems has received greater attention for its potential to remove particulate matter and other contaminants. Biochar is expected to have excellent potential as an adsorbent or filter given its large surface area and micro-porous structure. This study evaluated the potential use of biochar as a filter media through a series of column experiments. A column with an inner diameter of 2.75 in. (7 cm) and a length of 24 in. (61 cm) using biochar as filter media was constructed to examine its effectiveness for the removal of mixed contaminants (total suspended solids [TSS], nutrients, heavy metals, PAHs, and E. coli) from synthetic stormwater. Results demonstrated that this filter reduced the TSS in the stormwater effluent by an average of 86% and the concentrations of nitrate and phosphate by 86 and 47%, respectively. After filtration, the concentration of Cd, Cr, Cu, Pb, Ni, and Zn (heavy metals) decreased by 18, 19, 65, 75, 17 and 24%, respectively. The variation can be explained in terms of the chemical behavior of the different heavy metals as well as the properties of the biochar. Among the three polycyclic aromatic hydrocarbons (PAHs) tested, biochar successfully removed phenanthrene (almost 100% removal efficiency) and achieved 76% removal efficiency for naphthalene, but resulted no removal of benzo(a)pyrene, with the average removal for the three PAHs was 68%. Biochar was not

efficient in removing E. coli from stormwater; and the concentration of almost 7,400 MPN/100mL in inflow was reduced to around 5,000 MPN/100mL in the outflow, representing a mean removal efficiency of 27%. Overall, the biochar used in this study showed promise to be an effective filter media for the removal of selected contaminants from urban stormwater runoff. However, additional research should be conducted using different types of biochars, produced from different feedstock and production conditions, to determine the most effective biochar that can simultaneously remove multiple contaminants from urban stormwater.

Martha Vaughan – Research Molecular Biologist at the USDA –ARS in Peoria, IL; martha.vaughan@ars.usda.gov.
Effect of Soil Biochar Amendment on Wheat Resistance to Fusarium Head Blight and Mycotoxin Contamination
Mycotoxin contamination of food and feed is among the top food safety concerns. Fusarium head blight (FHB) is one of the most important diseases of wheat and other cereal grains. Fusarium graminearum, the fungal pathogen responsible for FHB, reduces crop yield and results in contamination of grain with carcinogenic mycotoxins called trichothecenes. *F. graminearum* like other Fusarium spp. efficiently colonizes field crop residues such as wheat stubble and maize stalks. These pathogen reservoirs are primary sources of inoculum for FHB epidemics in wheat. Soil amendment with biochar can confer multiple benefits to plants including increased productivity and enhanced stress resistance. The objective of this study was to test whether biochar could enhance wheat resistance to *F. graminearum* disease severity and trichothecene contamination. Because biochar has also been shown to promote the growth of beneficial microorganisms within the rhizosphere, we further assessed the potential of biochar as a carrier system for applying the biocontrol agent Trichoderma harzianum which is known to be effective against several fungal soil-borne plant pathogens including *F. graminearum*.

Edward Colosky – Graduate Student at the University of Minnesota in St. Paul, MN; colos009@umn.edu.
A Survey of Biochars: Interactions with Dissolved Ammonia, Nitrate, and Phosphate
Prior published field- and lab-based studies show that biochar soil amendments can reduce nitrogen (N) and phosphorous (P) leached from soil, suggesting a biochar-nutrient interaction. Although studies have examined individual biochars N and P interactions, no study has systematically surveyed biochars from various production processes and different parent materials. This study examined the ammonium (NH4), nitrate (NO3), and phosphate (PO4) sorption potentials of over 30 different biochars using a simple 24 hr batch sorption experiment. The observed sorption coefficients vary for each biochar. There does not appear to be a clear feedstock dependency, but manure-based biochars exhibit leachable P. There are biochars that absorb all three nutrients, but the most common occurrence among biochars is that more phosphate is given off than absorbed. These results stress the need for an individual biochar to be screened to ensure that it possesses the desired property before field application.

Eve Pytel – Ecological Economist at Delta Institute in Chicago, IL; epytel@delta-institute.org.
Urban Wood as a Source for Biochar

The increase in the number of insect and storm damaged trees, particularly from the Emerald Ash Borer, has created an overwhelming supply of wood chips. There is an economic case to be made that government units can convert these liabilities into assets by selling wood chips for biochar.

Paul Anderson – "Dr TLUD" and biochar production at Juntos Energy Solutions NFP in Normal, IL; psanders@ilstu.edu.

Increasing Biochar Production with Micro- and Mini- Sized Methods and Devices

A rank-ordered list of sizes of biochar-production units is presented. At the small-size end, the various options are discussed in more detail, including Micro-gasifier cookstoves (example: TLUD stoves), Biochar barrels/kilns/ovens (example: Jolly Roger Ovens), a new effort with slightly larger "Trof Kilns" (not previously presented), and commercially available mid-size units (examples: Adam Retort, Chip Energy Biomass Furnace, and mobile units in Australia). Efforts to have continuous (vs. batch) production are discussed.

John Kelly – Professor at the Loyola University Chicago; jkelly7@luc.edu.

Impacts of Biochar Amendments on Soil Microbial Community Activity and Structure

Biochar is a solid material obtained from the carbonization of biomass. Biochar can be important as a soil amendment for improving cropland, especially in areas with depleted soils or lacking adequate water and chemical fertilizer supplies. However, there have been variable results reported for soil fertility with the addition of biochar, which may be due in part to the fact that specific soil and biochar properties were not taken into consideration. We investigated the chemical, biological, and physical properties of soils amended with biochar using a range of soils found in Illinois. Soils were mixed with biochar made from three different feedstocks (hardwood, corn stover, and Miscanthus) using various production methods (gassification, pyrolysis) at three different concentrations (0%, 1%, and 5% by weight). Soil-biochar mixtures were incubated in bottles to enable measurement of greenhouse gas production, and at the conclusion of incubations soil bacterial community composition was analyzed by deep sequencing of bacterial 16S rRNA genes via paired-end amplicon sequencing on the Illumina MiSeq platform. Data from the greenhouse gas emissions studies and microbial community evaluations will be discussed.

12. Akindele Azeez – Student at Northwest Missouri State University in Maryville, MO; s518591@mail.nwmissouri.edu.

Trace Elements in Soybean Plants Grown on Biochar Amended Soils in Northwest Missouri

Trace elements in two soils namely Sharpsburg Silty Clay Loam (soil A) and Higginsville Silty Clay Loam (soil B) and trace elements in biochar prepared from different raw materials namely Horse manure(HM), Poultry Litter (PL), Miscanthus (M), Corn (C), and Hardwood (HW) were determined by the ICP-OES. The samples were digested with aque regia to transform the trace elements from solid to liquid state. CHNS analysis was also carried out to determine the Carbon, Hydrogen, Nitrogen, Sulphur and Oxygen present in the soil, biochar and treated samples. The concentration of these elements differed from one sample to another. Statistical analyses were done to determine if significant difference existed in the trace elements concentration in both soils and biochar which included F-test for variance evaluation and t-test for mean comparison. The statistical analysis demonstrated that statistically significant difference were observed for the ICP-OES and CHNS analysis for the biochars, soils and treated soils.

6. M. R. Bayan – Principal Investigator of Research at Lincoln University in Jefferson City, MO; bayanr@lincolnu.edu. Coauthors: A. A. Valeyeva and B. R. Grigoryan – Kazan Federal University, Russian Federation.

Adsorption of Methylene Blue by Biochar Produced through Torrefaction and Slow Pyrolysis from Switchgrass

The present work involves a study of sorption of methylene blue (MB) by charcoal samples produced through torrefaction and pyrolysis processes from switchgrass (Panicum virgatum). The adsorption of MB was determined using the spectrometric analysis method at various pH, temperature values and MB concentrations. The heat treatment temperature during biochar production significantly influenced the surface chemistry of biochars indicating that biochar samples, based on their thermal history alone, can behave significantly differently in the rhizosphere or in their ability to adsorb pollutants. The pH of the solution containing MB significantly affected its adsorption by biochars but trends were markedly different. The concentration of MB was also affected by the adsorption behavior of the two charcoals. The results indicate that biochars can be produced with desired properties to solve specific agricultural or environmental needs.

7. M. R. Bayan – Principal Investigator of Research at Lincoln University in Jefferson City, MO; bayanr@lincolnu.edu. Coauthors: A. A. Shinkarev and B. R. Grigoryan – Kazan Federal University, Russian Federation; X. Liang – Missouri University of Science and Technology, Rolla, MO.

The Specific Surface Area and Pore Volume of Biochars Prepared from Various Herbaceous and Ligneous Feedstocks through Torrefaction and Pyrolysis

The present work involves a study of surface area (SA) and pore volume (PV) of charcoals produced through torrefaction and slow pyrolysis from various biomass feedstocks. The SA was determined by N2 technique. The biomass included both herbaceous [corn stover (Zea mays), miscanthus (Miscanthus gigantus), switchgrass (Panicum virgatum)] and ligneous [cedar (Juniperus virginiana), oak (Quercus alba), pine (Pinus alba), and willow (Salix humilis)] feedstocks. SA varied despite biomass lignin content. Torrefaction resulted in significantly lower SA and PV. Heat effect on SA development varied as slow pyrolysis increased SA of switchgrass biochar by nearly tenfold but increased the SA of corn stover biochar by fivefold. Although PV of biochars produced through slow pyrolysis was generally higher, no trend could be established between increase in SA and increase in total PV resulting from heat. The switchgrass and willow biochars had the highest SA and PV values when prepared through slow pyrolysis.

11. Elton Bicalho – Visiting Scholar at University of Minnesota in St. Paul, MN; eltonbicalho@ig.com.br.
Examining Potential Mechanisms for N_2O Suppression in Biochar Amended Soils
One of the most interesting observations following biochar additions in laboratory incubations has been the suppressed N_2O production rate compared to the control soil. However, the mechanism behind this effect has remained elusive. Laboratory incubations were conducted with different methods of mixing and pre-conditioning the biochar and soil for these incubations. The initial conclusions from this study are there is an interaction with air dry biochar and water that does release CO_2 initially. However, if the biochar is pre-moistened or exposed to a humid environment this effect is reduced. Lastly, the N_2O suppression was not affected by this water-biochar interaction.

3. Sriraam Chandrasekaran – Visiting Research and Development Engineer at the Illinois Sustaianble Technology Center, a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign; schandr@illinois.edu.
Biochar Modifications for Rubber Composite Applications
Biochar is a major by-product from a pyrolysis and gasification process. Biochar finds potential applications in soil amendment, fertilizer substitutes, carbon sequestration, super capacitors, adsorbents, etc. However, their applicability is limited by its properties such as low carbon content, low porosity and surface area. On-going research on biochar explores thermal and chemical treatment to utilize the biochar in an effective way. The current study focuses on modifying the biochar to replace carbon black in rubber composites applications using a wet chemical treatment processes. The biochar prepared will be subjected to a pretreatment process (oxidizing) with nitric acid at 100°C and subsequently reducing the strongly oxidized material using hydrazine hydrate similar to the method described by Alfe et al. (2012). The carbon content of the biochar ranges from 50% to 85%. Thus, it is more challenging to convert them to a high quality graphene-like films. At each stage of the conversion process the reactants, products and the by-products will carefully be characterized by appropriate techniques. The study will focus on exploring the suitability of the modified biochar as filling material in rubbers/polymers.

5. Junhua Jiang – Senior Research Engineer at the Illinois Sustaianble Technology Center, a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign; junhua@illinois.edu.
Biochar Supercapacitor Based Capacitive Deionization
Capacitive deionization (CDI) has emerged over the years as a robust, energy efficient and cost effective technology for desalination of water with a low or moderate salt content. The key issue limiting market penetration of the CDI technology is related to the cost of electrode materials. Biochar is the carbon-rich product produced from biomass precursors. It can be made at a considerably lower cost than conventional activated carbons through

pyrolysis of biomass materials. Therefore, the use of low-cost biochar in the supercapacitors has the potential to substantially reduce the cost of electrode materials. This work has demonstrated that the technology based on high performance biochar supercapacitors developed at the Illinois Sustainable Technology Center can be used to effectively decrease salt concentration of a dilute saltwater.

8. Bidhya Kunwar – Post Doctoral Research Associate at the Illinois Sustaianble Technology Center, a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign; bkunwar@illinois.edu.

Biochars for the Removal of Cr(VI) and Pb(II) from Aqueous Solutions

Biochars obtained from the fast pyrolysis of pine woodchips and switchgrass and the gasification of pine woodchips were used for the removal of Pb(II) and Cr(VI) from aqueous solution. Pyrolysis biochars were obtained at 425°C in an auger reactor whereas gasification biochar was obtained by pine woodchip gasification at ~ 350°C. These biochars were characterized by scanning electron microscopy (SEM), surface area (SBET) determination, and zero point charge measurements. Batch sorption studies were carried out at pH values from 2 to 10, adsorbate concentrations from 20 mg/L to 400 mg/L, and temperatures from 25°C to 45°C. Pb(II) and Cr(VI) adsorption were quantitatively followed using atomic adsorption spectroscopy. The pH of 2.0 and 5.0 was optimum for Cr(VI) and Pb(II) sorption, respectively. The Langmuir and Freundlich isotherms were used to elucidate the absorption mechanism. Sorption follows pseudo second order kinetics with regression coefficients of 0.90 or better.

2. Tae-Jun Lim – Visiting Scholar at the University of Minnesota in St. Paul, MN; limxx413@umn.edu.

The Effect of Biochar Additions on Saturated Hydraulic Conductivities of Different Soils

The different properties of biochar, which is made out of a variety of different biomass materials, can effect water movement through soil. The objective of this research was to evaluate the saturated hydraulic conductivity (Ksat) when four different kinds of biochar were added to three different soils (coarse-, fine-, and clay textured soils), respectively. Particle size distribution of each biochar was measured. Biochar was mixed at the rates of 1, 2, and 5 % (w/w). The saturated hydraulic conductivity universally decreased when biochar was added to sandy and fine-sand textured soils, as a function of the rate. In addition, biochar with larger particles sizes (60%; >2 mm) had a more significant impact on decreasing Ksat than the smaller particle size biochar (60%; <0.5 mm). On the other hand, for clay soil 1% biochar addition increased Ksat, with 2% and 5% of biochar addition providing no further significant increases. These results suggest that Ksat is influenced by the particle size distribution of biochar, the application rate, and the original soil textures.

10. Zhongzhe Liu – Post Doctoral Researcher at Marquette University in Milwaukee, WI; zhongzhe.liu@marquette.edu.

Demonstration Scale Production of Nutrient-Enhanced Biochar via Biosolids Pyrolysis

Dried wastewater biosolids are an established type of soil conditioner produced by municipalities such as the Milwaukee Metropolitan Sewerage District (MMSD) through thermal drying of sewage sludge. In fact, MMSD produces 50,000 tons of dried biosolids every year. Dried biosolids are applied throughout North America to golf courses, turf farms and home lawns with slow release organic nitrogen. Though biosolids are currently used for land application purposes, they contain micropollutants such as antimicrobials and detergents which have rendered biosolids more difficult to market. Pyrolysis may be a solution to reduce the volume of biosolids, produce energy, and remove these micropollutants. Meanwhile, a more valuable and stable agricultural soil amendment, biosolids-derived biochar, can be produced. A demonstration scale pyrolytic system is being developed to generate 5 lb/hr biochar continuously, and energy and mass balances will be performed. The biochar product can be further enhanced by using it to adsorb ammonium from nutrient-rich wastewater to form a new nutrient-charged bio-fertilizer. During turfgrass growth experiments, this nutrient-charged biochar performed similarly to commercial inorganic fertilizer.

4. Kurt Nagel – Graduate Assistant at Northwest Missouri State University in Maryville, MO; s516855@mail.nwmissouri.edu.
Biochar Characterization
Biochar as a soil amendment has been shown to effect soil properties such as bulk density, water holding capacity and nutrient cycling. Factors such as biochar type, production method, soil type and plant type are known to cause variation in these effects. For this reason research specific to regional sets of these factors is warranted when considering suitability of biochar application in said region.This study focuses on the potential of adopting biochar amendments in NW Missouri, as a form of carbon sequestration as well as a beneficial soil amendment in terms of crop production. All of the study's biochars share some similarities. Some key differences are observable in analysis methods such as SEM imaging, water holding capacity, and bulk density measurements.

9. Rena Weis – Student at University of Minnesota and USDA-ARS in St. Paul, MN; weisx035@umn.edu.
The Impacts of Biochar on Field Greenhouse Gas Emissions and Soil Moisture Over Three Years
The purpose of this study was to examine the impacts of biochar additions on soil greenhouse gas emissions and soil moisture at the field plot scale. Triplicate plots (4.9 x 4.9 m) were amended with 0.763 kg/m^2 of a pine-chip biochar (650°C; slow pyrolysis) and three plots were untreated as the controls on a collaborator farm in Elko, MN (Lester loam soil type). There were no significant differences observed between the biochar and control plots for nitrous oxide (N_2O) or carbon dioxide (CO_2) emissions over the three-year period. However, the biochar plots emitted significantly lower amounts of methane. This observation could be due to increased soil aeration following biochar amendment. Biochar plots possessed statistically higher soil moisture contents during the first year and were equal to the control plots in year 2 and 3, suggesting that the physical hydrologic properties of the biochar changed during the winter/early spring thaw.

1. Lee Yang – Student at the University of Minnesota in St. Paul, MN; yang2447@umn.edu.
Magnetite: Another Link Between Terra Preta de Indio Soils and Biochar
Recently, the occurrence of fertile dark-colored soils in the Amazon [Anthropogenic Dark Earths or terra preta de Indio (TPI)] has been associated with early anthropogenic soil modification through additions of black carbon and other organic amendments from both agricultural and waste management activities of ancient Amazonian natives, which is

supported by the presence of artifacts (e.g., ceramic pieces) located within these soils. Here we show data that supports the hypothesis that magnetic minerals could be a potential mechanism leading to the stabilization of SOC in these TPI soils. We hypothesize that the presence of these ferromagnetic minerals (magnetite) lowers C mineralization rates through reduced microbial and extracellular enzymatic activity in the generated magnetic domains, thus leading to higher SOC accumulation.

13. Erin Yargicoglu – Student at the University of Illinois at Chicago; eyargi2@uic.edu.
Biochar-Amended Landfill Cover Soils for Enhanced Methane Oxidation: Coupled Laboratory and Field Investigations
Landfill emissions constitute a significant source of anthropogenic methane, with annual releases of up to 38.1 Tg CH_4 globally (IPCC, 2007). Biochar has been identified as a promising cover soil amendment for enhanced microbial methane oxidation in landfills due to its high internal porosity, gas adsorption properties, and suitability as a substrate for microbial colonization. In this ongoing study, different types of biochar-amended landfill soil covers were packed into acrylic columns and incubated with synthetic landfill gas (60% CH_4, 40% O_2) and air for several months in order to examine methane oxidation efficiencies attained in each biochar-amended cover type over long timescales using a mass balance approach. Batch incubation tests and microbial characterization of the biocover materials following the column incubation study will be used to examine the impact of biochar-amendment on methane-oxidizing bacterial communities and overall oxidation rates within the cover soils. A related study is also being undertaken to evaluate field-scale performance of selected designs to be installed at an active landfill in northern Illinois.

ABOUT THE ILLINOIS BIOCHAR GROUP

The Illinois Biochar Group (IBG) has members from throughout the Midwest and encourages research in the production and use of biochar. The group informs and educates others about biochar and its potential for applications in agriculture, site remediation, and carbon sequestration.

The Illinois Biochar Group is hosted by the Illinois Sustainable Technology Center and is affiliated with the International Biochar Initiative. Steve Peterson of the USDA-ARS is the currently the coordinator of the IBG.

To learn more, visit www.biochar.illinois.edu.

ABOUT THE ILLINOIS SUSTAINABLE TECHNOLOGY CENTER

The Illinois Sustainable Technology Center (ISTC) is a division of the Prairie Research Institute on the University of Illinois at Urbana-Champaign campus. Its mission is to encourage and assist citizens, businesses, and government agencies to prevent pollution, conserve natural resources, and reduce waste to protect human health and the environment of Illinois and beyond.

To learn more, visit www.istc.illinois.edu.

ABOUT THE UNITED STATES DEPARTMENT OF AGRICULTURE

The United States Department of Agriculture (USDA) was founded in 1862 and signed into law by President Abraham Lincoln. Its mission is to provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on sound public policy, the best available science, and efficient management.

To learn more, visit www.usda.gov.

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