Biochar Application Effects on Soil Phosphorus Sorption and Release

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The behavior of the soil after biochar application is mostly unexplored although much has been mentioned about the importance of biochar in reducing excess nutrient loss. The objective of this study was to determine the effects of commercially available biochars on P sorption and release from soils after addition of biochar at different rates. Hardwood biochar (HWB) and poultry litter biochar (PLB) were added to each of two soils (Candler and Apopka) at rates of 1%, 2% and 5% (w/w). Soil and each mixture were incubated at 25 ^{0}C for 14 days. At the end of the incubation period, 8 levels of P in the form of KH_2PO_4 solution were added to each of the treatments. Results showed that after certain limits of P addition (~4.5 mL/g for Candler and 15 mL/g of P for Apopka), corresponding to a threshold P saturation ratio (PSR), P began to be released from the soils for all treatments irrespective of the nature of the biochar. The amount of P sorbed in the solid phase was higher for PLB (~500 mg/kg) as compared to HWB (~320 mg/kg) for all rates of application. The absolute amount of additional P that can be added to a soil as fertilizer will depend on the P retention property of the soil and not on the biochar, and therefore would be site-specific. Increase in S_{max}, the Langmuir P retention maximum, with increase in biochar rates might be a result of additional moisture being retained by biochar.

An Energetic Perspective on Sweet Potato: Food versus Fuel

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Sweet potato (*Ipomoea batatas* L.) is a major starch-based crop that can be consumed as a nutritious dietary staple or converted into fermentable sugars for ethanol production. There are over 8000 varieties of sweet potato that have been bred for specific purposes. Varieties used for fuel generally have higher dry matter and starch contents, resulting in improved storage and increased ethanol yields, respectively. A high-dry matter sweet potato variety, CX-1, is being evaluated as a replacement crop for failing citrus groves in Florida since it can grow in hot climates, requires minimal irrigation and nutrients, and has a short growth cycle (150 days). The research objective is to determine whether sweet potatoes in Florida should be grown for human consumption or fuel production based on agronomic yield, potential energy production from both roots and culls, and nutrient recovery for animal forage. Varieties for comparison include Beauregard (food) and CX-1 (fuel). Ninety-six (96) plants of each variety were planted on June 6, 2014. Growth monitoring is conducted every six weeks and root/vine yields will be measured at harvest. Net energy values from ethanol production are twice that of edible energy for humans. Specific methane yields obtained from anaerobically digesting the culls were 333 and 255 LCH_4/kgCOD for Beauregard and CX-1, respectively. CX-1 culls have higher crude protein, nitrogen and phosphorus, while Beauregard are higher in fiber (CF, NDF, and ADF) and in vitro organic matter digestibility. Preliminary results favor CX-1 for ethanol production, but agronomic yields are essential for conclusive results.

DRIVERS OF METHANOGENESIS PATHWAYS IN SUBTROPICAL WETLANDS: FLORIDA EVERGLADES AS A CASE STUDY

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Methane production in WCA-2A regions of the subtropical freshwater Florida Wetlands has been shown to vary spatially along the nutrient gradient that extends from the eutrophic extrerior of the wetland to the oligotrophic interior. Although both acetoclastic and hydrogenotrophic pathways of methane production have been reported, their drivers are not fully understood. We investigated the effects of organic matter quality on methanogenesis pathways using manipulated soil laboratory incubations using CH_3F. Soil samples were collected from three different sites in the Water Conservation Area 2A of the Everglades dominated by different plant species; *Typha domingensis Pers.*, *Nymphea odorata* and *Cladium jamaicense Crantz*. We used biogeochemical properties and solid-state ^{13}C-CPMAS-NMR spectroscopy to determine the organic matter quality. Methane and CO_2 production decreased with soil depth from 0-5cm to 30-40cm and decreased with increasing alkyl, alkyl:o-alkyl ratio, dissolved organic carbon, and C:P ratio and with decreasing P, MBC, and MBN in all sites. Hydrogenotrophic methanogenesis dominated in all sites and depths apart from 5-10cm depth in F1 (63%) and U3S (57%) site. Methane ^{13}C ranged from -49 to -73. Acetoclastic methane production significantly decreased with increasing alkyl (P = 0.0117; R^2 = 0.697) and alkyl: o-alkyl ratio (P = 0.0051; R^2 = -0.749) but not significantly so for hydrogenotrophic methane production (P = 0.0892; R^2 = 0.511) and (P = 0.2215; R^2= - 0.381) respectively. Acetoclastic methanogenesis correlated positively with aromatic in F1 site (P= 0.0058; R^2= 0.994) but negatively in U3S (P= 0.0232; R^2= -0.977) and U3R (P= 0.0744; R^2= -0.926).

Organic matter recalcitrance appears to facilitate hydrogenotrophic pathway over acetoclastic pathway. Changes in organic matter quality will shift the dominant methanogenesis pathways and influence CH_4 production.

Chromate and Phosphate Inhibited Each Other's Uptake and Translocation in Arsenic Hyperaccumulator *Pteris vittata* L

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Abstract

We investigated the effects of chromate (CrVI) and phosphate (P) on their uptake and translocation in As-hyperaccumulator *Pteris vittata* (PV). Plants were exposed to 1) 0.05 mM CrVI and 0, 0.05, 0.25 or 1.25 mM P or 2) 0.25 mM P and 0, 0.05, 0.25 or 1.25 mM CrVI for 24 h in hydroponics. PV accumulated 2,919 mg/kg Cr in the roots at $CrVI_{0.05}$, and 5,100 and 3,500 mg/kg P in the fronds and roots at $P_{0.25}$. When co-present, CrVI and P inhibited each other's uptake in PV. Increasing P concentrations reduced Cr root concentrations by 62–82% whereas increasing CrVI concentrations reduced frond P concentrations by 52–59% but increased root P concentrations by 11–15%. Chromate reduced P transport, with more P being accumulated in PV roots. Though CrVI was supplied, 64–78% and 92% CrIII were in PV fronds and roots. Based on X-ray diffraction, Cr_2O_3 was detected in roots confirming CrVI reduction to CrIII by PV. In short, CrVI and P inhibited each other in uptake and translocation by PV and CrVI reduction to CrIII in PV roots served as its detoxification mechanism. The finding helps to understand the interactions of P and Cr during their uptake in PV.

Keywords: Chromium; *Pteris vittata*; Uptake; Translocation; Speciation

Comparison of Soil Organic Nitrogen Composition and Mineralization by Vegetation Type in Subtropical Wetlands

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Ninety five percent of the soil nitrogen (N) is in organic N forms, yet only 50% of the soil organic nitrogen (SON) forms are known. Studies in upland systems indicate SON composition is similar despite vegetation differences. However, it is unknown if anaerobic conditions will result in similar SON compositions in wetland soils. The objective of this study was to compare SON composition and mineralization in a wetland that contains different vegetation types. A constructed wetland in south Florida containing two vegetation types with similar nutrient status and soil age was chosen for this study. We hypothesized vegetation type doesn't influence SON composition. Soil cores were obtained from each vegetation type and sectioned into floc (unconsolidated detrital material), recently accreted soil, and antecedent soil. The diffusion method was used to determine SON composition by separating soil N pools into amino sugar-N and amino acid-N. Mass spectrometry was used to qualitatively identify SON molecular composition. Absence of significant differences between amino sugar-N and amino acid-N, as a percent of total N, indicate vegetation type is not the main driver of SON gross pools. Differences in molecular composition of proteins with depth indicate a slight decrease in the relative abundance of proteins in EAV, while an increase in the relative abundance of proteins in SAV. Although gross N pools indicate vegetation is not the main driver, the molecular composition suggests differing relative abundance of proteins and amino sugars with vegetation, which may be important for the stability of SON in subtropical wetlands.

Toxicity of an Imidazolium-Based Ionic Liquid on Wheat

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Abstract

Ionic liquids (ILs) are green solvents, which have unique physicochemical properties and potential applications in various areas. However, recently the toxicity of ILs to crops has attracted increasing attention. The present paper studied the toxic effects of 1-octyl-3-methylimidazolium hexafluorophosphate ($[C_8mim]PF_6$) on wheat seedlings after exposing to 0, 1, 2, 4, 6, or 8 $mg \cdot L^{-1}$ for 7, 10 or 13 d. The results showed that the growth of wheat seedlings was seriously inhibited at $[C_8mim]PF_6$ concentration > 2 $mg \cdot L^{-1}$ and the inhibition increased with increasing concentration and exposure time. The EC50 values for germination, shoot length, root length and dry weight were 11.1, 5.19, 4.38 and 6.29 $mg \cdot L^{-1}$, respectively. $[C_8mim]PF_6$ increased the production of ROS, leading to the oxidative damage and lipid peroxidation in wheat. Furthermore, these toxic effects on wheat seedlings were irreversible.

Keywords wheat, antioxidase system, lipid peroxidation, superoxide anion, EC50

Fate of Trace Organic Compounds Drip-Dispersal Septic System Drainfield

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Trace organic compounds (TOrC), including pharmaceuticals, personal care products, and hormones, are present in household wastewater. As TOrC are not completely removed in the septic drainfield, they can potentially contaminate groundwater. Our objective was to understand the occurrence, behavior, and leaching of TOrC in septic drainfield. Three replicate drainfield (1.5 m length, 0.9 m wide, 0.9 m height) contained vertically stacked layers of sand-gravel mix (7.5 cm), soil (30 cm), and sand (30 cm). A drip line dispersed 9 L of septic tank effluent (STE) per day in each drainfield (equivalent to 3L/ft^2/day), which was covered with 15-cm depth of sand and then St. Augustine grass was planted to mimic a residential system. Collected STE and leachate samples each day in the beginning (n=44) and then weekly flow-weighted samples (n=100) were analyzed for selected TOrC. In STE, acetaminophen, ibuprofen, and caffeine were the most frequently (>90%) detected compounds following by estrone (80%), bisphenol-A (70%), sulfamethoxazole (59%), and carbamazepine (56%). In leachate, ibuprofen (12 ng/L) and bisphenol-A (36 ng/L) were the most detected (>65%) compounds. Sulfmethoxazole (33%; 24 ng/L) and estrone (20%; 6 ng/L) were detected in leachate at lower frequencies. Mean concentrations of detected TrOC in STE were 55 -11,700 ng/L; while concentrations were only 6-36 ng/L in leachate. These results indicate that attenuation of TrOCs as STE infiltered in the vadose zone. Only three compounds, acetaminophen (0.25-2.0 ng/g), carbamazepine (0.07-0.60 ng/g), and sulfamethoxazole (0.13-3.73 ng/g) persisted in soil samples collected at the end of experiment (1-year). Mass balance calculations show that <10% of applied TrOCs in STE were recovered in leachate, with the remainder either accumulated in soil and/or biodegraded or transformed in the drainfield.

Root Colonization of *Exophiala pisciphila* Enhances Tolerance of Maize (*Zea mays* L.) to Cadmium

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Abstract: Dark septate endophytes (DSE) commonly exist in plant roots grown in heavy metals contaminated soils. The role of DSE in heavy metals tolerance of their host plants is not well-documented. In this study, maize (*Zea mays* L.) was not or inoculated with a DSE strain (*Exophiala pisciphila*) in the roots and grown in pots with cadmium (Cd) contaminated sand at 0, 10, 20, 40 and 80 mg/kg. Results showed increase in Cd concentration in the sand caused a decrease in the height and biomass of maize and increase in the contents of malondialdehyde (MDA) and ascorbic acid (Vc), and antioxidant capability (T-AOC) in the maize leaves. Compared with non-inoculation treatments, root colonization of *E. pisciphila* enhanced the height by 19% and 25%, plant biomass by 26% and 24% at 40 and 80 mg/kg Cd stress; increased Vc content and T-AOC by 34% and 32% at 40 mg/kg Cd stress, respectively. In summary, root colonization of DSE enhanced the Cd tolerance of maize plant by improving the antioxidant capability at high Cd stress.