INFLUENCE OF PYROLYSIS TEMPERATURE AND PRODUCTION METHOD ON SWITCHGRASS BIOCHAR FOR USE AS A SOIL AMENDMENT

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Abstract

Biochars are thought to form recalcitrant carbon and increase water retention in soils, while enhancing plant growth by promoting soil-nutrient adsorption. However, the magnitude of this is contingent upon production conditions and thermo-chemical conversion processes. Herein we aim at (i) characterizing switchgrass-biochar morphology, (ii) estimating soil water-holding capacity under increasing ratios of char: soil; and, (iii) determining nutrient profile variation as a function of pyrolysis conversion methodologies (i.e. continuous, externally-heated auger versus carbonized batch systems) for terminal use as a soil amendment. Auger system chars produced at 600°C had the greatest lignin portion by weight, indicating higher recalcitrance, whereas lower production temperatures (400ºC) yielded greater hemicellulose (i.e. greater mineralization promoting substrate). Under both pyrolysis methods, increasing soil application rates in our silt loam soil resulted in linear decreases in bulk density (g cm^{-3}). Increases in auger-char (400°C) applications, increased soil water-holding capacities; however application rates of >2 Mt ha^{-1} are required. Whereas carbonized batch chars did not influence water-holding abilities (P>0.05). Biochar macro and micro nutrients tended to become sequestered in char fractions, as heating values increased in the batch system from 400-600°C; whereas nitrogen levels tended to decrease. Consequently, all chars are not inherently equal, in that varying operation systems, resident times, and production conditions can greatly impact uses as a soil amendment and overall rate for efficacy, and it cannot be assumed that all chars increase soil water-holding capacities, nutrient retention, and improve soil tilth.

ENHANCING THE SUSTAINABILITY OF LIGNOCELLULOSIC FEEDSTOCK PRODUCTION SYSTEMS IN THE SOUTHEAST AND UNDER INTENSIFIED CLIMATIC CHANGE

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Abstract

Second-generation feedstocks such as switchgrass (*Panicum virgatum* L.) have been proposed as sustainable alternatives to fossil fuels although still require non-renewable inputs, notably, inorganic-nitrogen (N). Further, climate change forecasts suggest southeastern USA may emulate more tropical growing conditions. Therefore, objectives were to determine i) effects of biochar (1 and 2 Mg ha^{-1}), three intercropped legumes [red clover (*Trifolium pretense* L.), partridge pea (*Chamaecrista fasciculata* L.), and sun hemp (*Crotalaria juncea* L.)] versus inorganic-N [67 kg $ha^{-1}$and 0 kg ha^{-1} (control)] on desired feedstock characteristics, yield, and soil characteristics; ii) biomass nutrient remobilization for post-senescence (November 15th) and overwintering (February 1st) harvests in a two-factor randomized block design; and, iii) switchgrass adaptation to more extreme (tropical) growing conditions. Experiments in tropics included a switchgrass relative, guinea grass (*Panicum maximum* L.), with sun hemp and pigeon pea (*Cajanus cajan* L.) intercrops. Over-wintering harvests increased phosphorus and potassium remobilization, ethanol yield, fructan, digestible sugars, and field dry-down ($P \leq 0.05$), although, yield losses occurred (22%). November harvests had greater tissue-N and digestible nutrients, leading to greater soil-nutrient removals. Consequently, harvests manipulated desired feedstock traits, whereas soil amendments had little effect on feedstock characteristics. Results from tropics and temperate sites (post-senescence) suggest legume intercrops (pigeon pea and sun hemp, partridge pea, respectively), and biochar may supply analogous-N as synthetic fertilizers ($P \leq 0.05$). Switchgrass adaptation was moderate (5-30% weed cover) under the proxy for climatic change, and can therefore be maintained under stochastic climates, due to its drought tolerance, genetic diversity, and competitive growth on marginal soils.