Effects of peanut shell and pine wood biochars on soil chemical properties and pearl millet (*Pennisetum americanum* L.) yield.

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Introduction

Biochar is a promising amendment for enhancing soil fertility and crop productivity. Biochars have potential to increase soil nutrient status and water holding capacity while simultaneously reducing leaching losses, and thus may lower fertilizer input needs.

Objectives

To determine the effects of biochar sources and rates under fertilized conditions on soil chemical properties and millet productivity.

Methods

Peanut shell and pine wood biochars (Table 1) were applied to a typic Hapludult in Montgomery Co., VA. Soil and plant data were collected over two growing seasons.

Table 1: Chemical properties of soil and biochar sources.

	Ash	pH_{H20}	EC	C	N	C:N	CEC
	%		dS/m	---- % ----			meq/100g
Soil		6.41	0.23	1.52	0.15	10.3	4.7
Peanut shell	6.0	10.2	0.8	19.0	0.6	31.1	22.0
Pine wood	5.1	9.6	0.6	16.1	0.3	59.6	18.6

Experimental Design

The field experiment was conducted as a completely randomized design. Biochar sources were applied at 0, 10, or 20 Mg/ha as part of a larger fertility study

Treatment plots

Ion-Exchange Membranes (IEMs)

To assess temporal changes in soil nitrate (NO_3^-) and ammonium (NH_4^+) concentrations, IEMs (GE Power & Water, Trevose, PA, USA) were inserted to a depth of 15 cm, replaced and analyzed at 4-week intervals over the growing season.

IEMs

Soil Sampling and Analysis

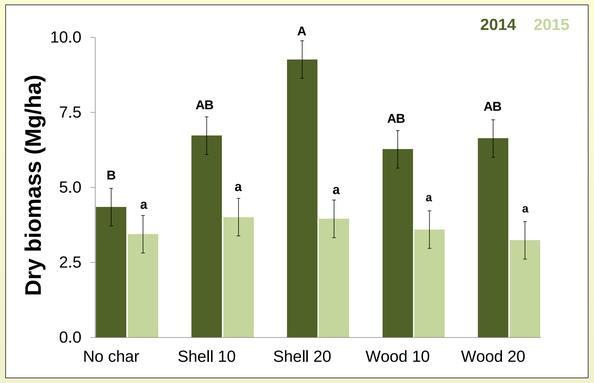
Samples (0-15 cm depth) collected after harvest each year.
Soil test analyses: Routine tests and total soil C and N.

Plant sampling and Analysis

Millet parameters: leaf chlorophyll with atLEAF+ SPAD meter (FT Green, LLC, Wilmington, DE) and biomass yield

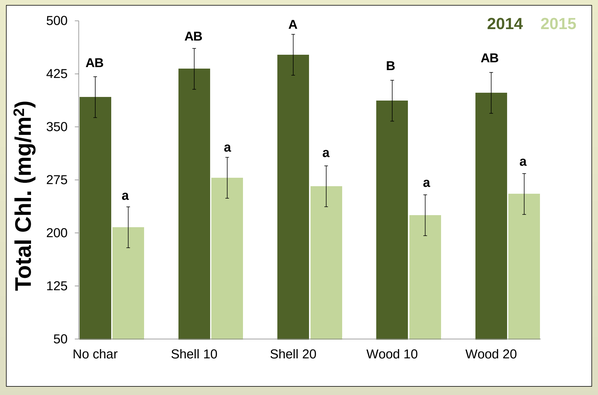
atLEAF+ Chlorophyll Meter

Effects of Biochars on Millet Dry Biomass



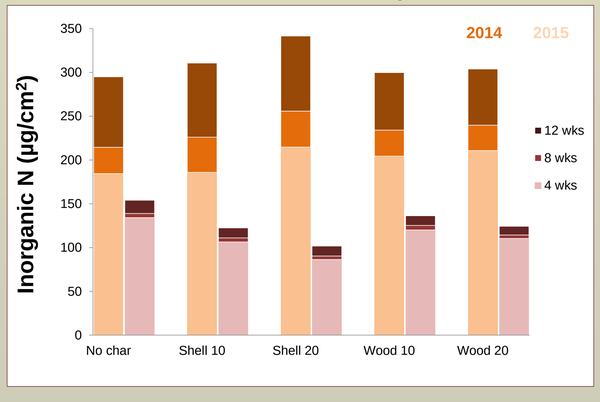
Peanut shell biochar applied at 20 Mg/ha maximized millet dry biomass yield in 2014. Biochar effects did not persist in 2015.

Effects of Biochars on Leaf Chlorophyll



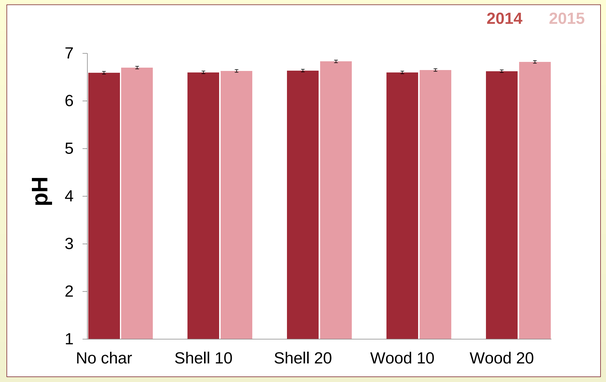
End of season leaf chlorophyll concentration was not affected by biochar application in either year.

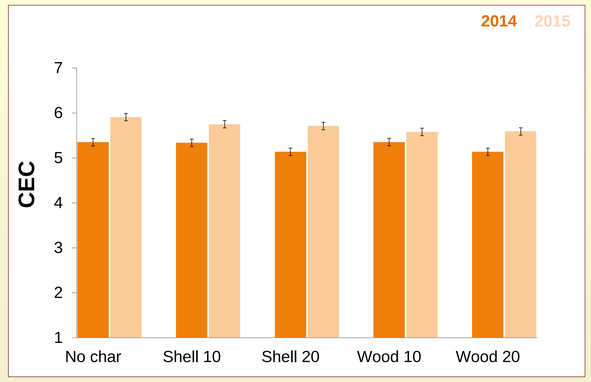
Effects of Biochars on Soil Inorganic N



Most inorganic N was available in the first four weeks of the growing season in each year. Soil inorganic N was not affected by biochar amendment.

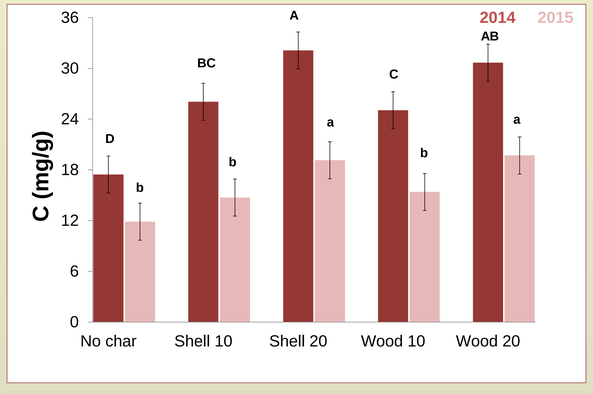
Effects of Biochars on Soil pH and CEC

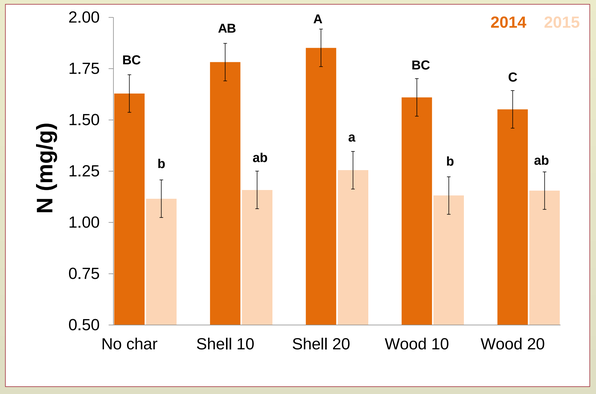




Neither peanut shell nor pine wood biochars significantly increased soil pH or CEC in the soil surface (0-15 cm) despite the expected liming effect (pH=~10) and high CEC (≥ 18.6) of biochar sources..

Effect of Biochars on Soil C and N





Higher soil C concentrations were observed with peanut shell and pine wood biochar application. Soil N concentrations were higher only with high rates of peanut shell biochar application due to its greater N content.

Conclusions

- Peanut shell biochar supported greater millet yield in 2014. Yield effects were not observed in 2015.
- Biochar amendments had little effect on end-of-season leaf chlorophyll concentration.
- Soil inorganic N in solution was not affected by peanut shell and pine wood biochars. Most inorganic N was available the first four weeks of each growing season.
- Soil pH and CEC were unaffected biochars. Numeric increases in pH with high biochar application rates suggest that longer periods of time may be required to measure this effect in a fertile, loamy soil.
- Biochar application increased soil C, but in 2015 these effects were only observable with high application rates.
- In both years, soil N was only increased with high rates of peanut shell biochar.

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