Soil Chemical Changes of Coastal Plains Ultisols with Winter Wheat: Contrasting Effects of Sorghum Biochars and Sorghum Residues

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ABSTRACT

- Results fully support experimental hypothesis that sorghum biochars (SB) would deliver more positive effect on the changes of soil chemical properties than sorghum residues (SR).
- Overall, application of SB had small, but significant effects on soil pH, soil electrical conductivity (EC) total carbon (TC) and total nitrogen (TN). Quite notably was the significant difference of these soil properties between soil types.
- Other aspects of soil chemical changes including extractable P, K, Ca, Mg, Al and Fe were significantly affected by sorghum treatments.
- Results have demonstrated widely differing and contrasting effects between SB and SR on changes in soil chemical properties of Coastal Plains Ultisols.

BACKGROUND AND OBJECTIVE

- The fertility of highly weathered Ultisols in the southeastern Coastal Plain region of the U.S. is low. In this region, intensive crop production depletes soil nutrients and reduces soil organic C.
- Application of organic residues (e.g., sorghum, corn, soybeans, etc.) is critically needed for fertility maintenance of Ultisols as it leads to the formation of humus.
- Although most soil properties were improved following application of crop residues and/or pyrolyzed crop residues, there is a need to pursue additional research that will improve our understanding on the impact of soil fertility enhancement because the effect could vary greatly between SB and SR.
- The objective of this study was to evaluate the contrasting effects of SR and SB with or without supplemental inorganic phosphorus (P) on soil chemical changes of Coastal Plains Ultisols with winter wheat.

MATERIALS AND METHODS

1. Soils and Biochar Production – Two soils were used in the study: Norfolk soil (fine loamy, kaolinitic,thermic, Typic Kandiudults and Dunbar soil (fine, kaolinitic, thermic, Aeric Paleaquults). Grain sorghum (*Sorghum vulgaris* L.) stovers were hand collected from a 7.7-ha field at the Coastal Plains Soil, Water, and Plant Research Center in Florence County, SC. The raw sorghum residues was hammer milled to approximately 6 mm particle size.

Pyrolytic runs of the raw sorghum residues were performed at 500 °C. Prior to a run, the sorghum was oven-dried (103°C) overnight and then loaded into a mesh basket and placed into a Lindburg electric box furnace equipped with a gas tight retort (Model 51662; Lindburg/ MPH, Riverside, MI).

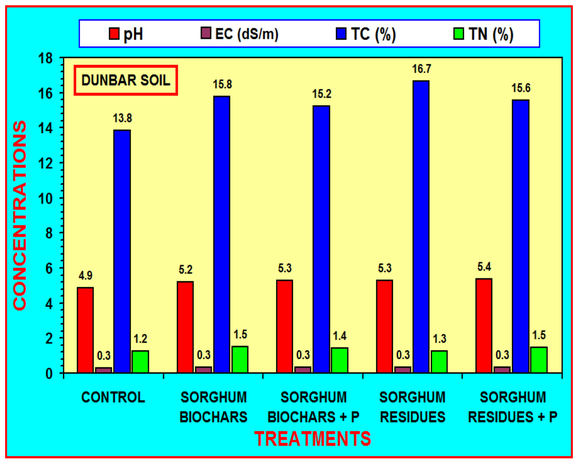
2. Application Rate: 13 Mg/ha for Sorghum Residues (SR) and Sorghum Biochars based on 200 bushels/ha yield goal; 40 kg P/ha.

3. Experimental Design and Greenhouse Set-Up: (2 x 5 split plot in complete block design).

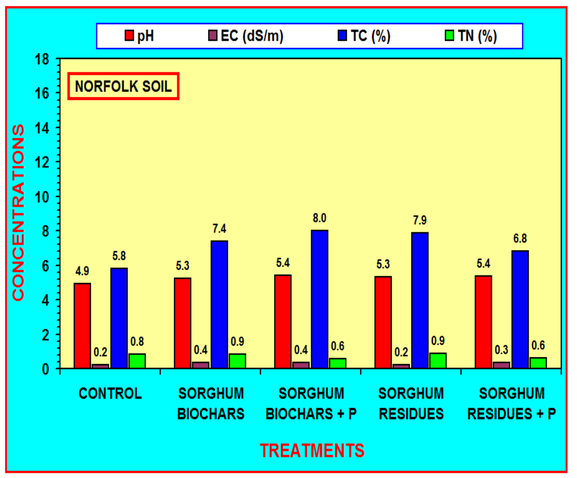
Collecting Soil Samples after Harvest

Separating Belowground Biomass

RESULTS AND DISCUSSION



Soil pH and EC varied significantly with sorghum treatment. Incorporation of sorghum residues with or without P and sorghum biochars with or without P in Dunbar soils resulted in significantly higher soil pH than in the control. Overall, sorghum treatments had small, but significant effects on soil TC and TN. Average increased of TC (Dunbar: 16%; Norfolk: 27%).



Contrasting effects of SB and SR additions on extractable P, K, Ca, and Mg in two soils.

A. Dunbar Soils

Treat	P	K	Ca	Mg
Control	97.8c*	66.9c	443.1c	116.2b
SB	106.6b	175.4b	448.0c	118.1b
SB + P	117.6a	170.3b	479.3ab	122.9a
SR	105.9b	250.4a	471.1bc	132.9a
SR + P	120.3a	246.1a	507.7a	136.3a

B. Norfolk Soils

Treat	P	K	Ca	Mg
Control	17.3b*	34.5b	211.4c	38.0b
SB	20.5b	91.8a	228.8bc	48.9a
SB + P	30.2a	79.3a	255.7a	49.4a
SR	19.4b	78.6a	233.5b	51.1a
SR + P	28.3a	75.8a	256.1a	50.3a

*Means in columns within each heading followed by common letter(s) are not significantly different form each other at p≤0.05.

Concentrations of Mehlich extractable P, K, Ca and Mg varied significantly with sorghum treatments. There were greater increase for treatments with sorghum biochars + P compared with the control soil. These results demonstrate favorable effects of SB in augmenting soil P, K, Ca and Mg.

SUMMARY AND CONCLUSION

- Biochar produced from the sorghum straw through pyrolysis process and SR had contrasting effects on chemical changes of two Ultisols in Coastal Plains region.
- Results may seem to indicate that conversion of SR to SB is a better strategy for both environmental and crop productivity improvement in Coastal Plains region.
- Contrasting effects of SR and SB as reported in our study could be important in terms of satisfying the long term environmental risk assessment and better understanding for the use of uncharred and pyrolyzed crop residues in agriculture.

REFERENCES

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