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Impacts of Soil Physical Quality by Organic and Inorganic Amendments

Atanu Mukherjee* and Rattan Lal

Carbon Management and Sequestration Center

2021 Coffey Road, Columbus, OH: 43210

The Ohio State University

ASA Section: Environmental Quality

Session: Biochar Effects On Soils, Plants, Waters, and Greenhouse Gas Emissions: II

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* Corresponding Author: mukherjee.70@osu.edu

Hypotheses

- Bulk Density, Surface Area are better improved by biochar due to its higher porosity but Aggregate Stability by Humic Acid addition due to higher complexation ability
- Soil-C is stabilized more by biochar compared to that by other amendments due to its refractory nature
- Green House Gas (GHG) emissions are suppressed more with biochar due to microbial effect

Objectives

- Assess the impacts of various amendments on
  - ✓Soil quality
  - ✓GHG fluxes
  - ✓MRT of C, N
- Compare amendments based on their impacts and field suggestions

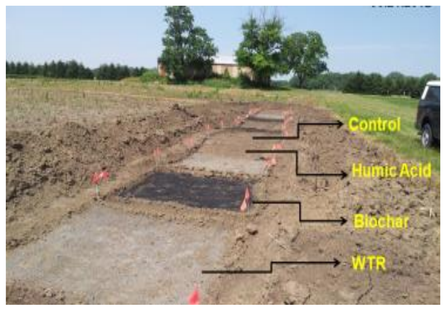
Materials and Methods

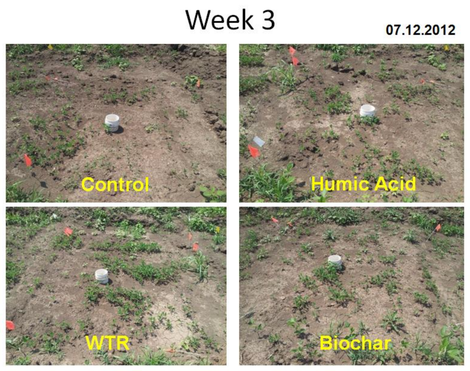
- Location of Soil Site: Waterman Farm, Columbus, Ohio (44º02”00”N, 83º02”30”W)
- Soil Characterization: Crosby Silt Loam (Soil Survey, 1996)
- Amendments: Biochar (Oak-650 ºC, 3 hour pyrolysis time), Humic Acid (HA) (Sigma Aldrich), Aluminium-Water Treatment Residuals (WTR) (Water treatment plant, Columbus, OH)

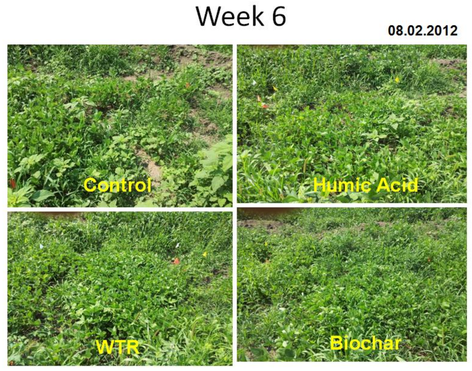
Experimental Design

Component 1: Field Scale

- 2 m x 2 m plots
- 3 Amendments, 1 Control (3 replications)
- Rate of application: 1% (w/w)
- Soybean planted
- Soil analyses: Bulk Density, Aggregate Stability, Surface Area, Porosity, Moisture Content, pH, C, N
- Monitored GHG emissions
- Yield of crop after 3.5 months





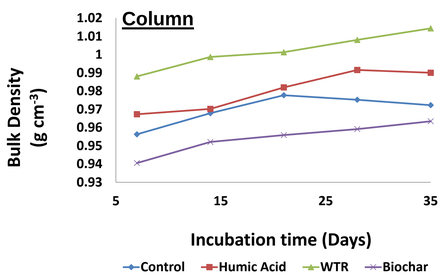


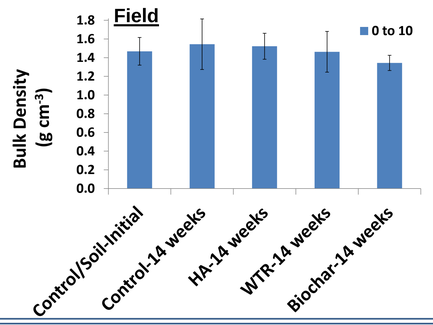
Component 2: Laboratory Scale

- 12 inches x 3.5 inches clear polyvinyl columns
- 1 kg soil + 10 g Amendments
- 3 Amendments, 1 Control (3 replications)
- Rate of application: 1% (w/w)
- Periodically leached with 200 mL water
- Soil analyses: Bulk Density, Surface Area, Porosity, Moisture Content, pH, C, N
- Leachate analyses: C, N
- Monitored GHGs

Results and Discussions

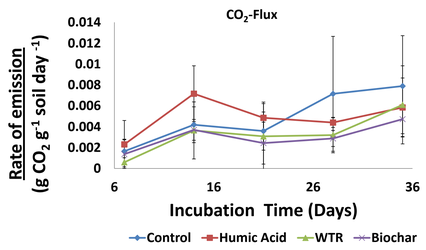
Bulk Density

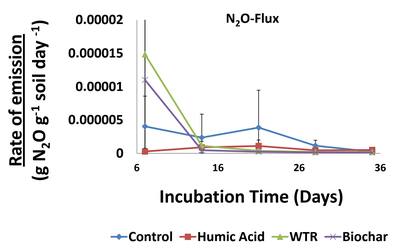


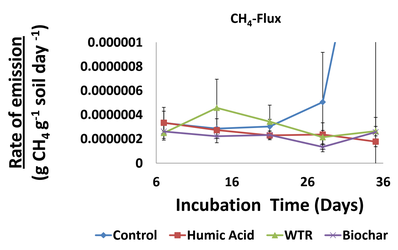


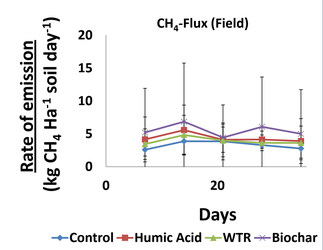
- Bulk Density of soil decreases only by biochar addition, specially on the top surface
- No effect in sub-soil after 14 weeks (data not shown)

Gas Emission Trends

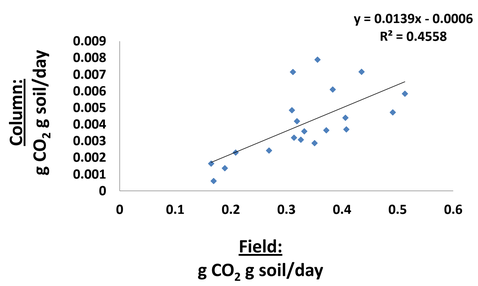






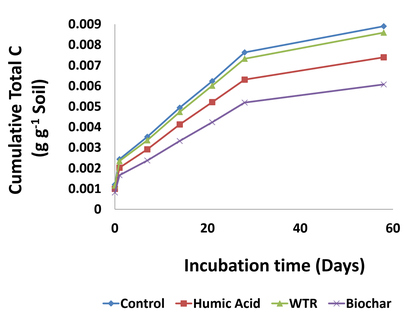


Lab Scale	Suppression of GHG fluxes		
	CH_4	CO_2	N_2O
Treatments		%	
Humic Acid	69.1	-2.2	82.9
WTR	62.2	32.7	1.9
Biochar	72.6	34.8	18.4



- All amendments indicated suppression of GHGs, specially from columns
- Column and field GHG emission data moderately correlated

Leaching of C (Column)



- All amended soils suggested reduction in C leaching compared to control soil
- Biochar amended soil leached lowest C over time compared to other amendments

Mean Residence Time (MRT)

Estimation of MRT of C

Scales →	Field	Column
Treatments ↓	Years	
Control	149	3
Humic Acid	329	20
WTR	409	16
Biochar	11,854	44

Literature Review: ~ 20,000 years

Zimmerman, 2010: 4 x 10^7
Cross and Sohi, 2011: 19,838
Peng et al. 2011: 244-1700

Estimation of MRT of N

Scales →	Field	Column
Treatments ↓	Years	
Control	0*	20
Humic Acid	51,740	143
WTR	67,7605	123
Biochar	1,04,986	660

* 11 days

- Higher stability of C and N by all amendments
- Biochar affected most on soil-C and soil-N stability compared to other amendments
- With preliminary estimation, MRT of C and N can go up to 10^4 and 10^6 years, respectively, with biochar addition