Measurement Of Carbon Dioxide In Corn Cob Biochar-amended Acid Soil Added With Different Types Of Fertilizers

ARSENIO D. BULFA, JR.

MS SOIL SCIENCE

What we will learn…

- Why biochar?
- CO_2 sequestration
- CO_2 evolution trends
- Effect in the environment

What is Biochar?

- Biochars are new, carbon-rich materials that could sequester carbon in soils

- Improves soil properties and agronomic performance

- Inspired by investigations of Terra Preta in Amazon.

Glaser, B., Wiedner, K., Seelig, S., Schmidt, H. P., & Gerber, H. (2015). Biochar organic fertilizers from natural resources as substitute for mineral fertilizers. Agronomy forSustainable Development, 35(2), 667-678.

Biochar

- The pyrolysis conversion of waste biomass into biochar is particularly attracting attention for the following two reasons.

  -it can be used as a soil amendment for improving soil quality and,
  -storing biochar in soils is regarded as a mean for permanently sequestering carbon.

Glaser, B., Wiedner, K., Seelig, S., Schmidt, H. P., & Gerber, H. (2015). Biochar organic fertilizers from natural resources as substitute for mineral fertilizers. Agronomy forSustainable Development, 35(2), 667-678.

Biochar

- environment-related benefits linked with biochar

- rehabilitation of degraded lands,
- reduced GHG emissions,
- adsorption of contaminants to offset streams, and groundwater pollution are among the

- It is well documented that biochar application into soil can reduce the emission of CO_2, CH_4, and N_2O

Hussain, M., Farooq, M., Nawaz, A., Al-Sadi, A. M., Solaiman, Z. M., Alghamdi, S. S., ... & Siddique, K. H. (2016). Biochar for crop production: potential benefits and risks. Journal of Soils and Sediments, 1-32.

What is biochar?

Biochar **is a highly porous material made from organic waste**

Can be any forest, agricultural, or animal waste

Examples:

- **Woodchips**
- **Corn husks**
- **Peanut shells**
- **Chicken manure**

Tian, Y., Sun, X., Li, S., Wang, H., Wang, L., Cao, J., & Zhang, L. (2012). Biochar made from green waste as peat substitute in growth media for Calathea rotundifola cv. Fasciata. Scientia Horticulturae, 143, 15-18.

More about biochar..

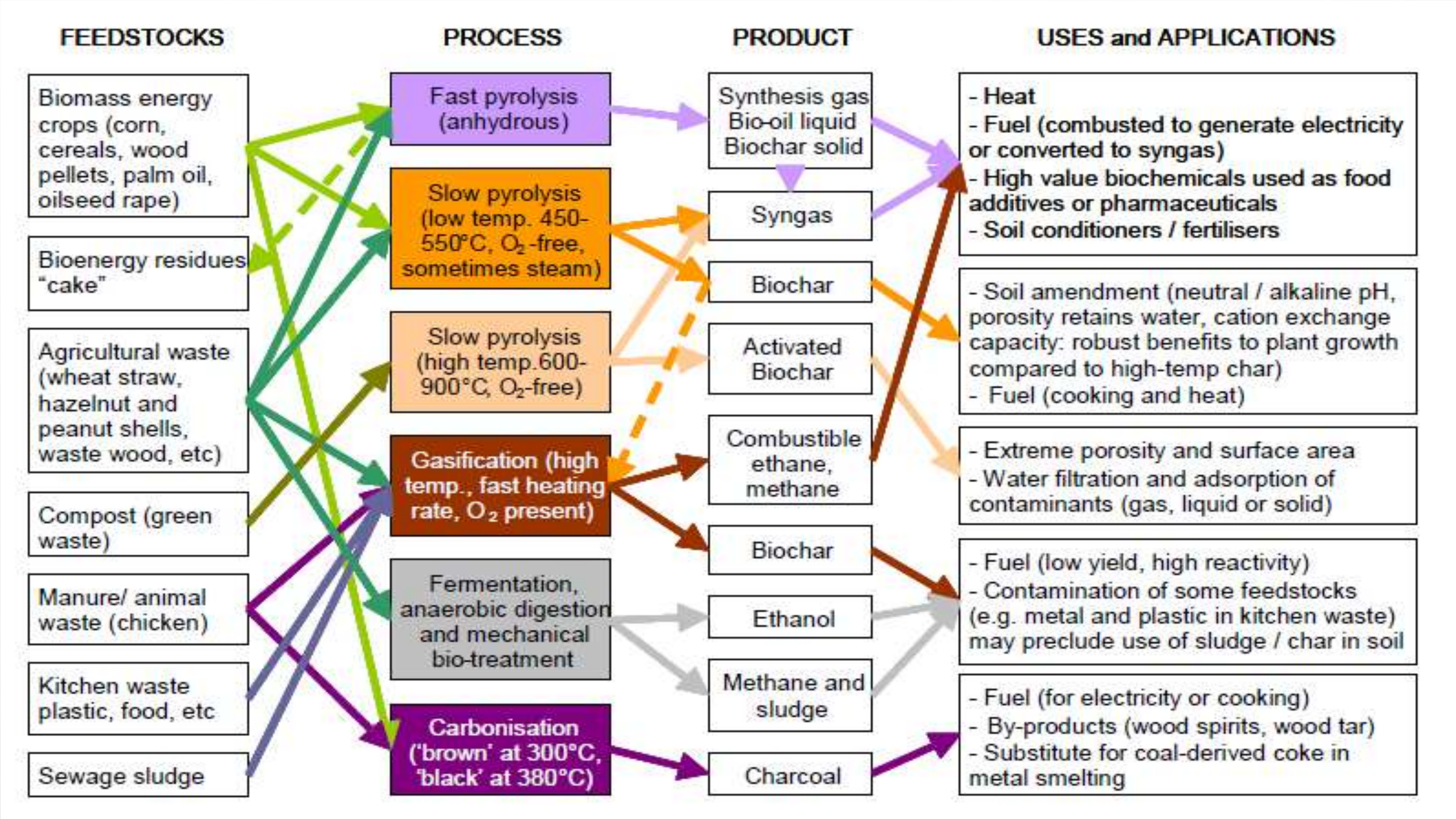
- Biochar is a carbon-rich solid material produced by heating biomass in an oxygen-limited environment

- Intended to be added to soils as means to sequester carbon(C) and maintain or improve soil functions.

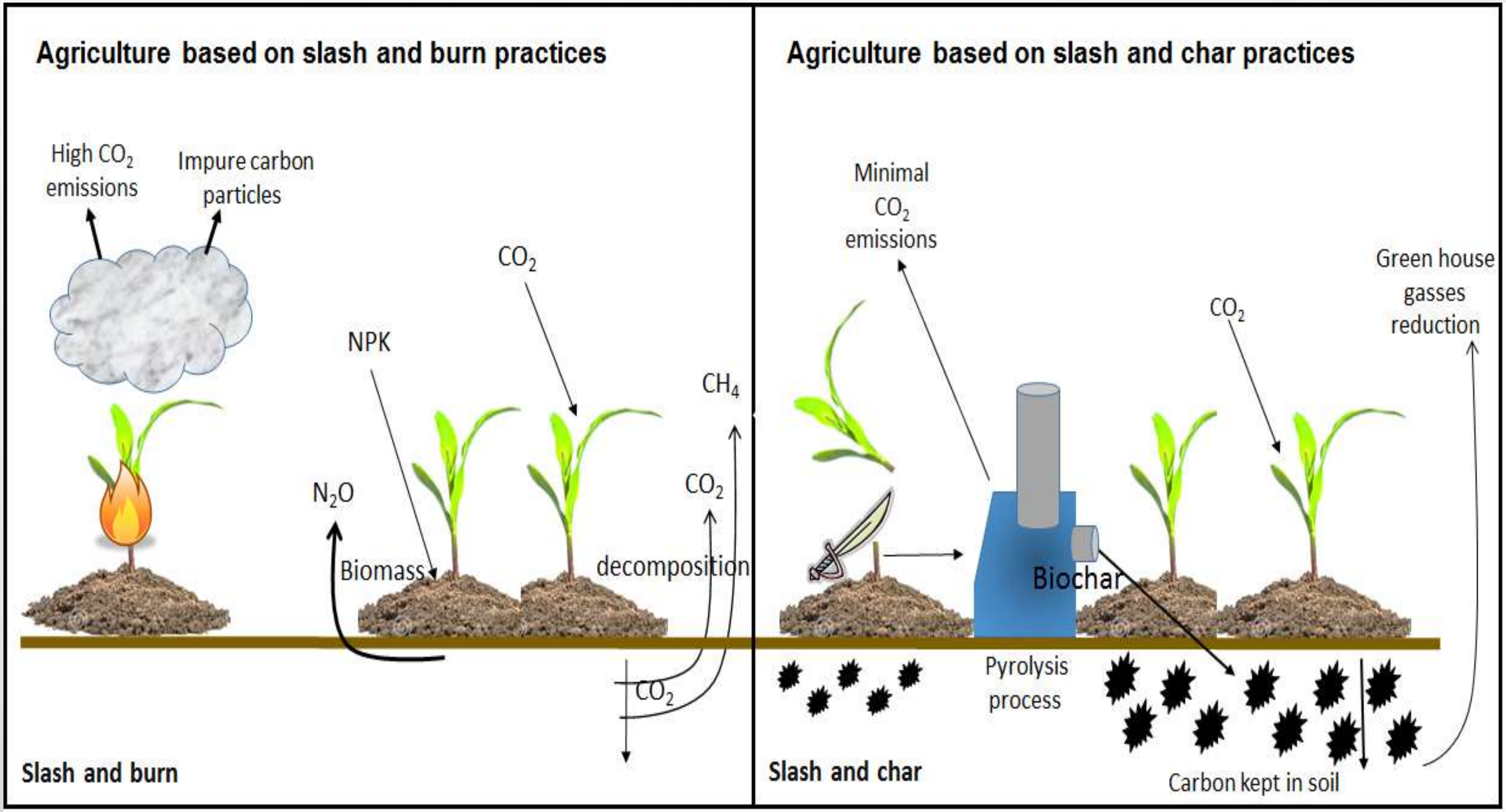
- It is produced after pyrolysis of biomass, typically within a temperature range of 300°C to 800 °C .

Van der Stelt, M. J. C., et al. "Biomass upgrading by torrefaction for the production of biofuels: A review." Biomass and bioenergy 35.9 (2011): 3748-3762.

Are all biochars the same?



Biochar and Agriculture

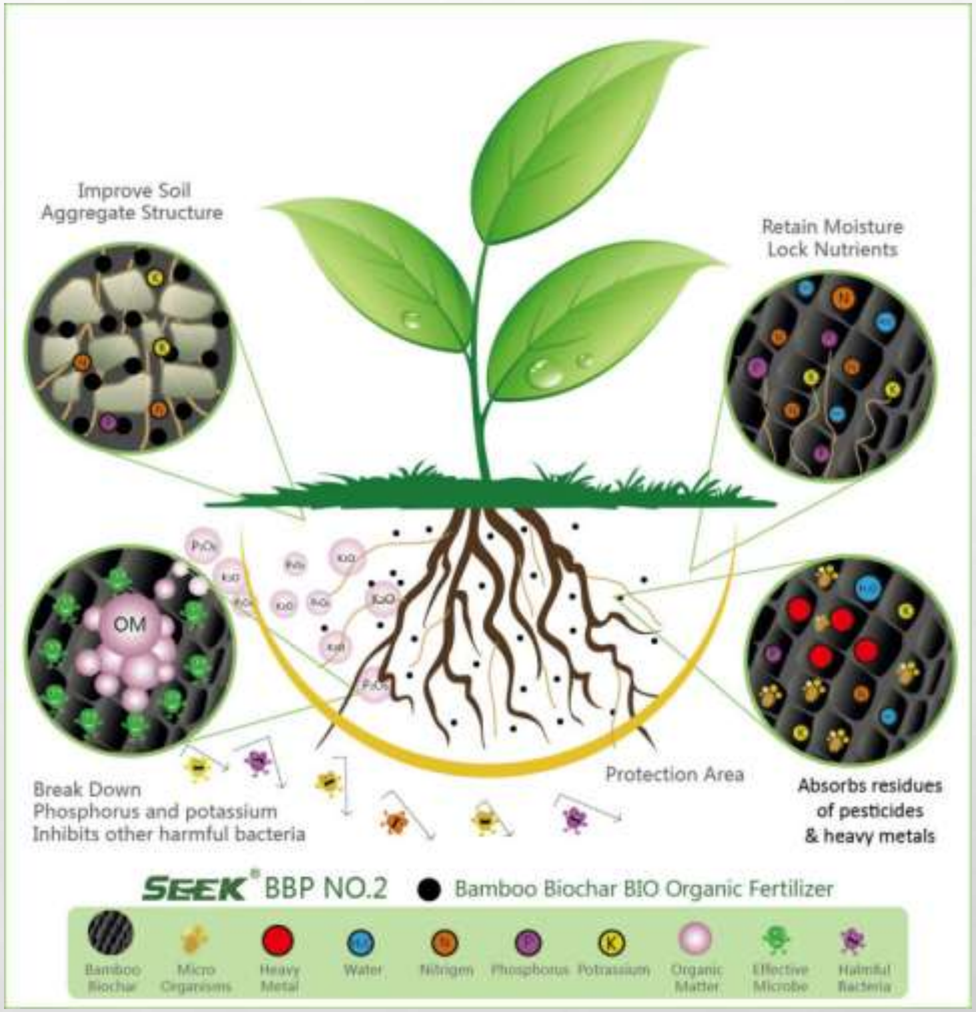


Lehmann, J., da Silva Jr, J. P., Rondon, M., Cravo, M. D. S., Greenwood, J., Nehls, T., ... & Glaser, B. (2002, August). Slash-and-char-a feasible alternative for soil fertility management in the central Amazon. In Proceedings of the 17th World Congress of Soil Science (pp. 1-12).

Biochar and Agriculture

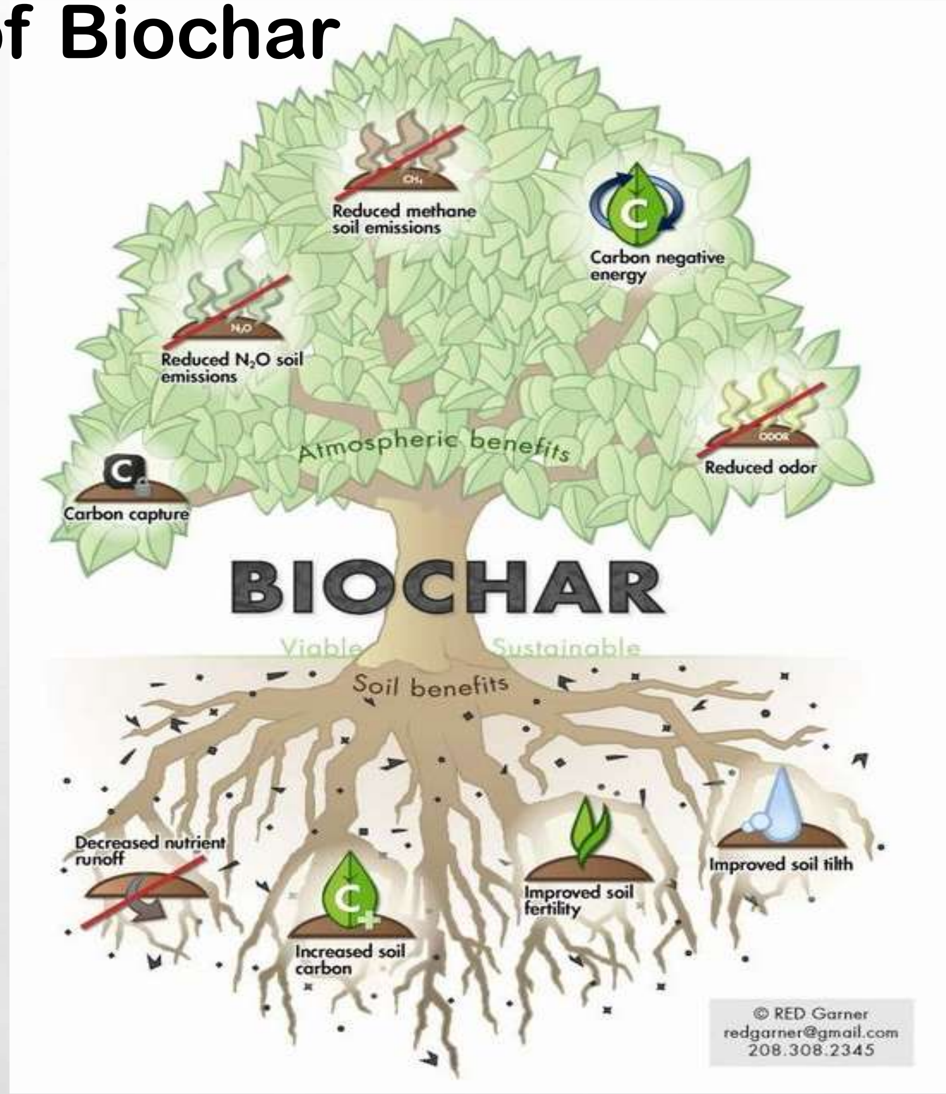
Gasifier Inno-technology for Negative Carbon Production (GIN-P) pyrolytic cook stove

Benefits of Biochar



Bates, A. (2010). The biochar solution: carbon farming and climate change. New Society Publishers.

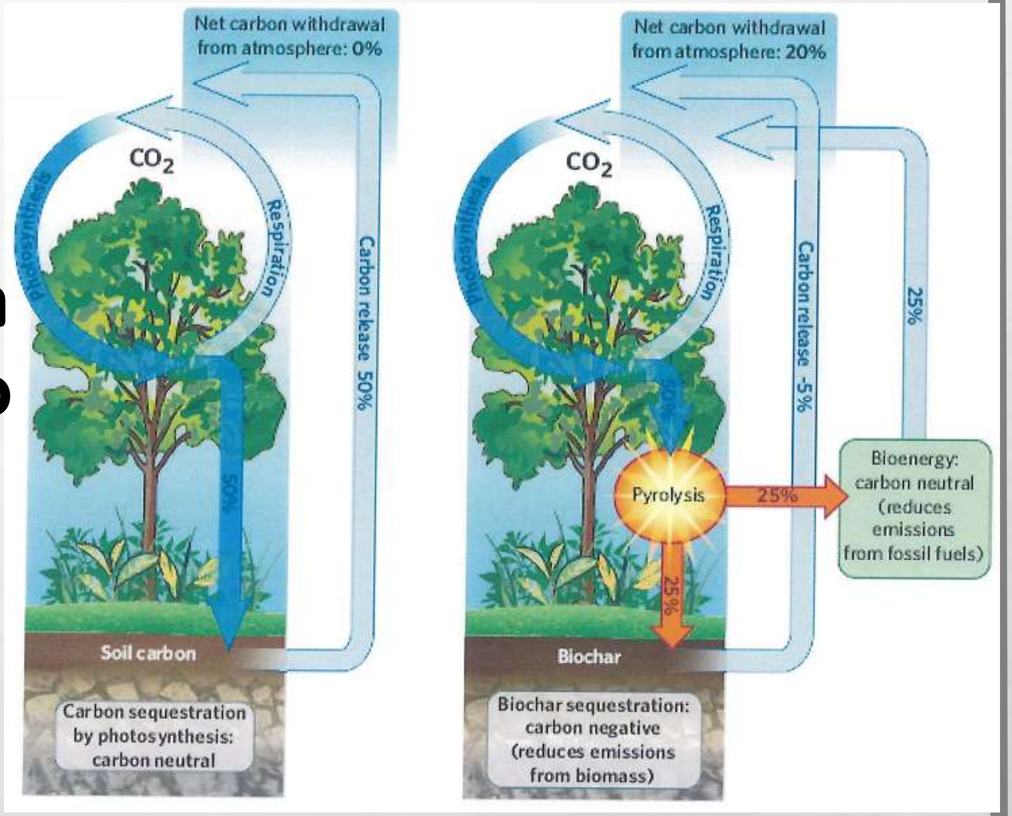
Benefits of Biochar



Sohi, S., Lopez-Capel, E., Krull, E., & Bol, R. (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Science Report, 5(09), 17-31.

Biochar and CO_2 Sequestration

- **biochar is a highly stable form of carbon and as such has the potential to form an effective C sink, therefore sequestering atmospheric CO_2.**



Sohi, S., Lopez-Capel, E., Krull, E., & Bol, R. (2009). Biochar, climate change and soil: A review to guide future research. CSIRO Land and Water Science Report, 5(09), 17-31.

Objectives

This experiment was conducted to give a close attention to the Effect Corn Cob Biochar on the Rate of Carbon Sequestration in Red Acidic Soil

-compare the CO_2 evolution trends of all treatments

-compare the sequestration rates

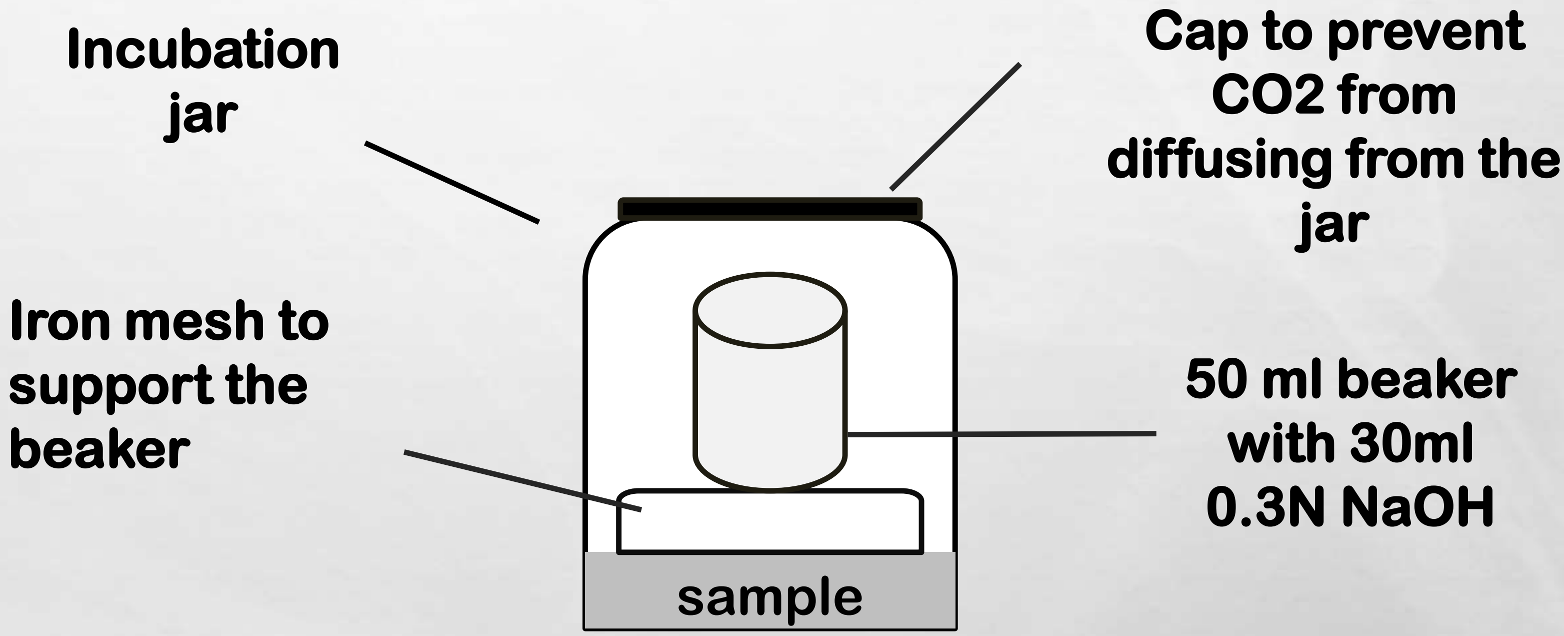
Materials and Methods
Preparation of Treatments

Treatments are as follows:

Treatment 1: Control (soil alone)
Treatment 2: T1 + biochar (10t/ha)
Treatment 3: T1 + *Gliricidia sepium* leaves
Treatment 4: T3 + biochar (10t/ha)
Treatment 5: T1 + rice straw
Treatment 6: T5 + biochar (10t/ha)
Treatment 7: T1 + inorganic fertilizer
Treatment 8: T7 + biochar (10t/ha)
Treatment 9: T1 + organic fertilizer (5t/ha)
Treatment 10: T9+ biochar (10t/ha)

Materials and Methods

Determination of Carbon Dioxide Evolution




50

Materials and Methods
Determination of Carbon Dioxide Evolution

Materials and Methods
Duration and Titration Schedule

- Titration was done in 2, 5, 7, 14, 21 and 28 days interval respectively.

Materials and Methods

Determination of Carbon Dioxide Evolution

Results were expressed as mg carbon dioxide produced per 100 grams soil. The formula used in calculating the carbon dioxide evolved was:

$$\text{mg of } CO_2 = \frac{(B-V) \times 22 \times N \times 2}{T}$$

where:

V = Volume (mL) of acid used to titrate

B = Volume (mL) of acid used to titrate the CO_2 trap to the end point

N = Normality of the acid

T = Time (in days)

22 = weight of 1 meq CO_2 in mg

Results

Chemical Properties of Luisiana Clay

Property	Value
pH	4.68
EC (mS/cm	0.049
N (% OM)	2.75 (M)
P (ppm)	6.24 (L)
K (meq/100g soil)	0.08 (D)

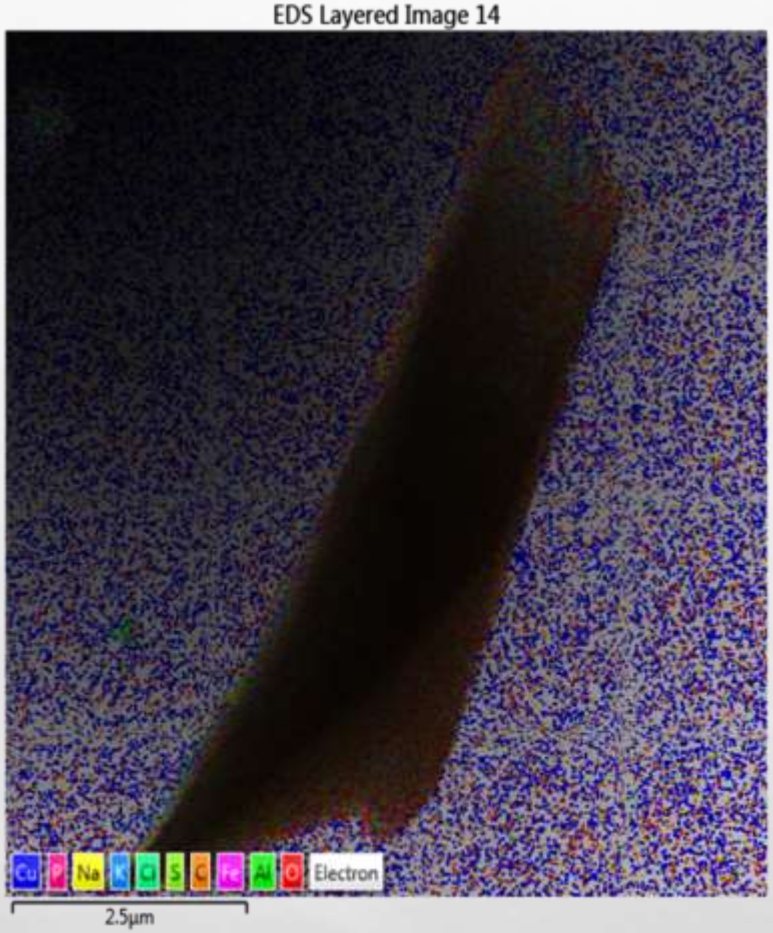
L = Low M = Medium H = High D = Deficient S = Sufficient

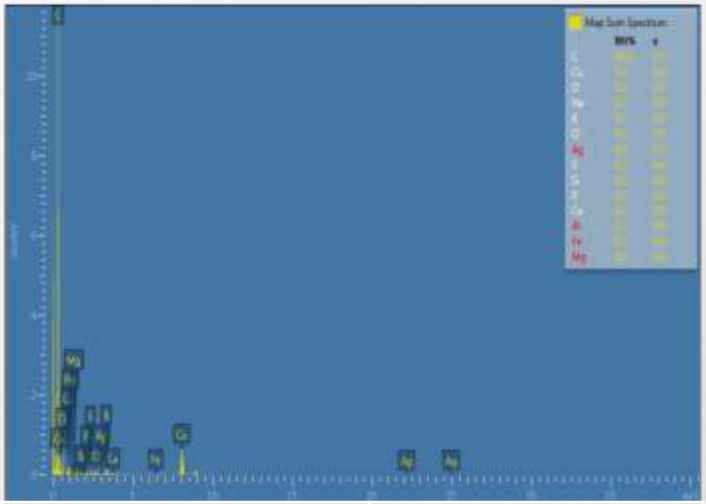
Results

Chemical Properties of Corn Cob Biochar

Property	Value
N (%)	1.29
P (%)	0.67
K (%)	2.70
Ca (%)	0.22
Mg (%)	0.51
Fe (ppm)	1024
Zn (ppm)	220
Cu (ppm)	14
Mn (ppm)	85

Energy Dispersive Spectroscopy (EDS) For Transmission Electron Microscope(TEM)





Element	Wt%
Carbon	88.4
Copper	5.4
Sodium	0.7
Potassium	0.7
Chlorine	0.5
Sulfur	0.2
Silicon	0.2
Phosphorus	0.2
Calcium	0.1

Corn Cob Biochar Surface Area

Analysis

Operator:	quantachrome	**Date:**2017/03/29	
Sample ID:	corn cob	**Filename:**	CORN COB SA.qps
Sample Desc:	black powder	**Comment:**	Surface Area Analysis
Sample weight:	0.1192 g	**Sample Volume:**	0.03056 cc
Outgas Time:	3.0 hrs	**OutgasTemp:**	300.0 C
Analysis gas:	Nitrogen	**Bath Temp:**	273.0 K
Press. Tolerance:	0.100/0.100 (ads/des)	**Equil time:**	60/60 sec (ads/des)
Analysis Time:	56.1 min	**End of run:**	2017/03/29 20:07:10
Cell ID:	9		

Report

Operator: quantachrome **Date:**2017/03/28

Equil timeout: 240/240 sec (ads/des)

Instrument: Nova Station B

Multi-Point BET

Data Reduction Parameters Data

Adsorbate	Nitrogen	**Temperature**	77.350K		
	Molec. Wt.: 28.013	**Cross Section:**	16.200 Å²	**Liquid Density:**	0.808 g/cc

Multi-Point BET Data

Relative Pressure [P/Po]	Volume @ STP [cc/g]	1 / [W((Po/P) - 1)]	Relative Pressure [P/Po]	Volume @ STP [cc/g]	1 / [W((Po/P) - 1)]
5.03120e-02	1.2068	3.5124e+01	2.03551e-01	2.5875	7.9030e+01
1.00989e-01	1.8962	4.7399e+01	2.54369e-01	2.8317	9.6392e+01
1.51140e-01	2.2726	6.2686e+01	3.04006e-01	3.0191	1.1576e+02

BET summary

Slope =	318.036
Intercept =	1.631e+01
Correlation coefficient, r =	0.997370
C constant=	20.495
Surface Area =	10.416 m^2/g

Corn Cob Biochar Pore Radius

Analysis			Report		
Operator:	quantachrome	**Date:** 2017/03/28	**Operator:**	quantachrome	**Date:** 2017/03/28
Sample ID:	corn cob	**Filename:**	CORN COB.qps		
Sample Desc:	black powder	**Comment:**	Pore Size Analysis		
Sample weight:	0.1192 g	**Sample Volume:**	0.03056 cc		
Outgas Time:	3.0 hrs	**Outgas Temp:**	300.0 C		
Analysis gas:	Nitrogen	**Bath Temp:**	273.0 K		
Press. Tolerance:	0.100/0.100 (ads/des)	**Equil time:**	60/60 sec (ads/des)	**Equil timeout:**	240/240 sec (ads/des)
Analysis Time:	228.6 min	**End of run:**	2017/03/28 18:46:32	**Instrument:**	Nova Station B
Cell ID:	9				

BJH Pore Size Distribution Desorption

Data Reduction Parameters Data

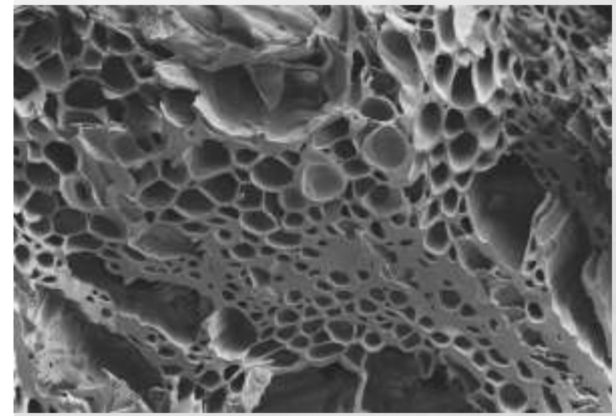
t-Method	**Calc. method:** de Boer				
BJH/DH method	**Moving pt. avg.:** off	**Ignoring P-tags below 0.35 P/Po**			
Adsorbate	**Nitrogen**	**Temperature**	77.350K		
	Molec. Wt.: 28.013	**Cross Section:**	16.200 Å²	**Liquid Density:**	0.808 g/cc

BJH Pore Size Distribution Desorption Data

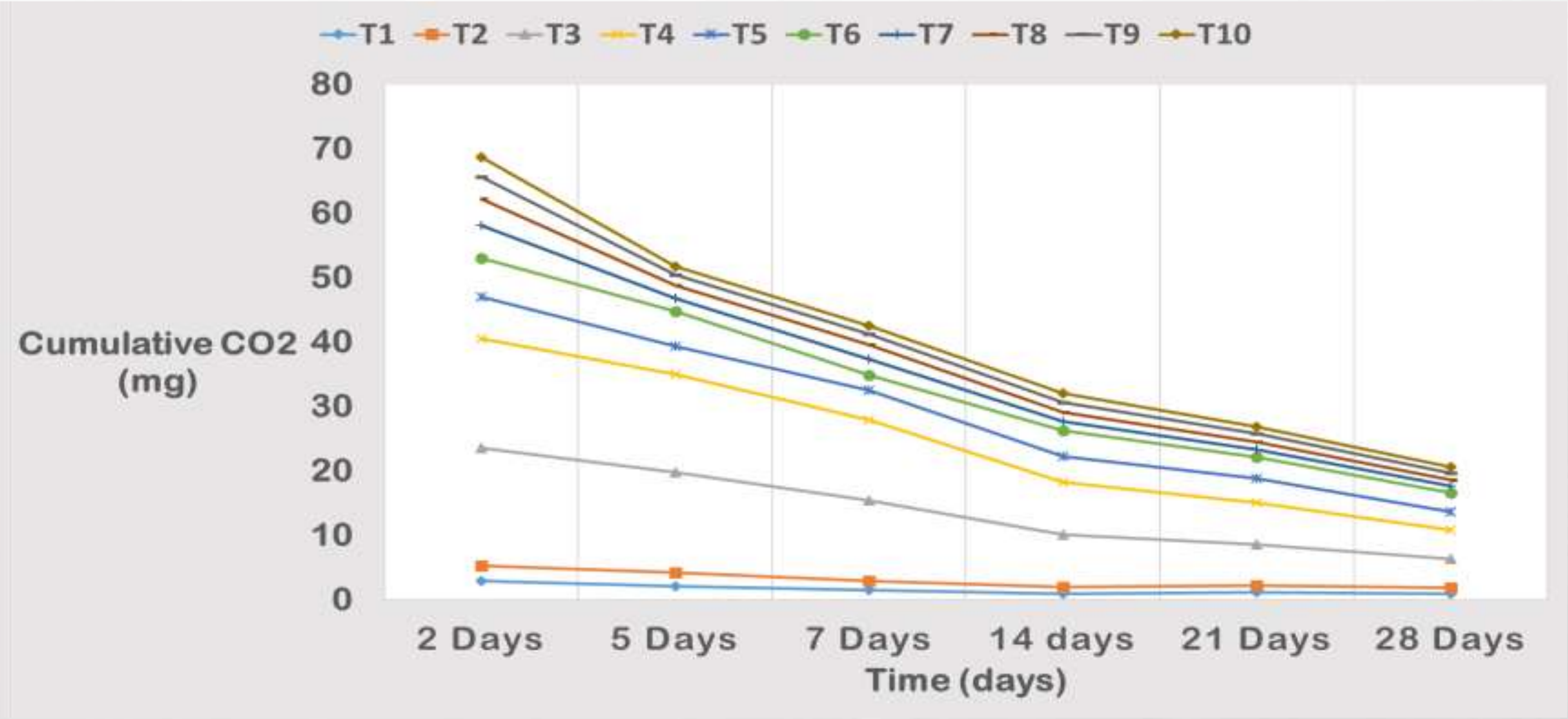
Radius [Å]	Pore Volume [cc/g]	Pore Surf Area [m²/g]	dV(r) [cc/Å/g]	dS(r) [m²/Å/g]	dV(logr) [cc/g]	dS(logr) [cc/g]
15.3348	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
17.1328	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
19.1571	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
21.4952	1.1266e-04	1.0483e-01	4.4771e-05	4.1657e-02	2.2134e-03	2.0594e+00
24.3733	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
28.0031	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
32.5185	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
38.6763	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
47.4358	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
61.3498	1.1266e-04	1.0483e-01	0.0000e+00	0.0000e+00	0.0000e+00	0.0000e+00
88.2346	1.7752e-04	1.1953e-01	1.7938e-06	4.0660e-04	3.5929e-04	8.1440e-02
151.5766	5.0640e-04	1.6292e-01	3.6329e-06	4.7935e-04	1.2293e-03	1.6221e-01
338.4845	1.3793e-03	2.1450e-01	3.0814e-06	1.8207e-04	2.2542e-03	1.3320e-01
728.6082	1.9576e-03	2.3037e-01	1.1635e-06	3.1938e-05	1.8739e-03	5.1437e-02

BJH desorption summary

Surface Area = 0.230 m²/g
Pore Volume = 0.002 cc/g
Pore Radius Dv(r) = 21.495 Å

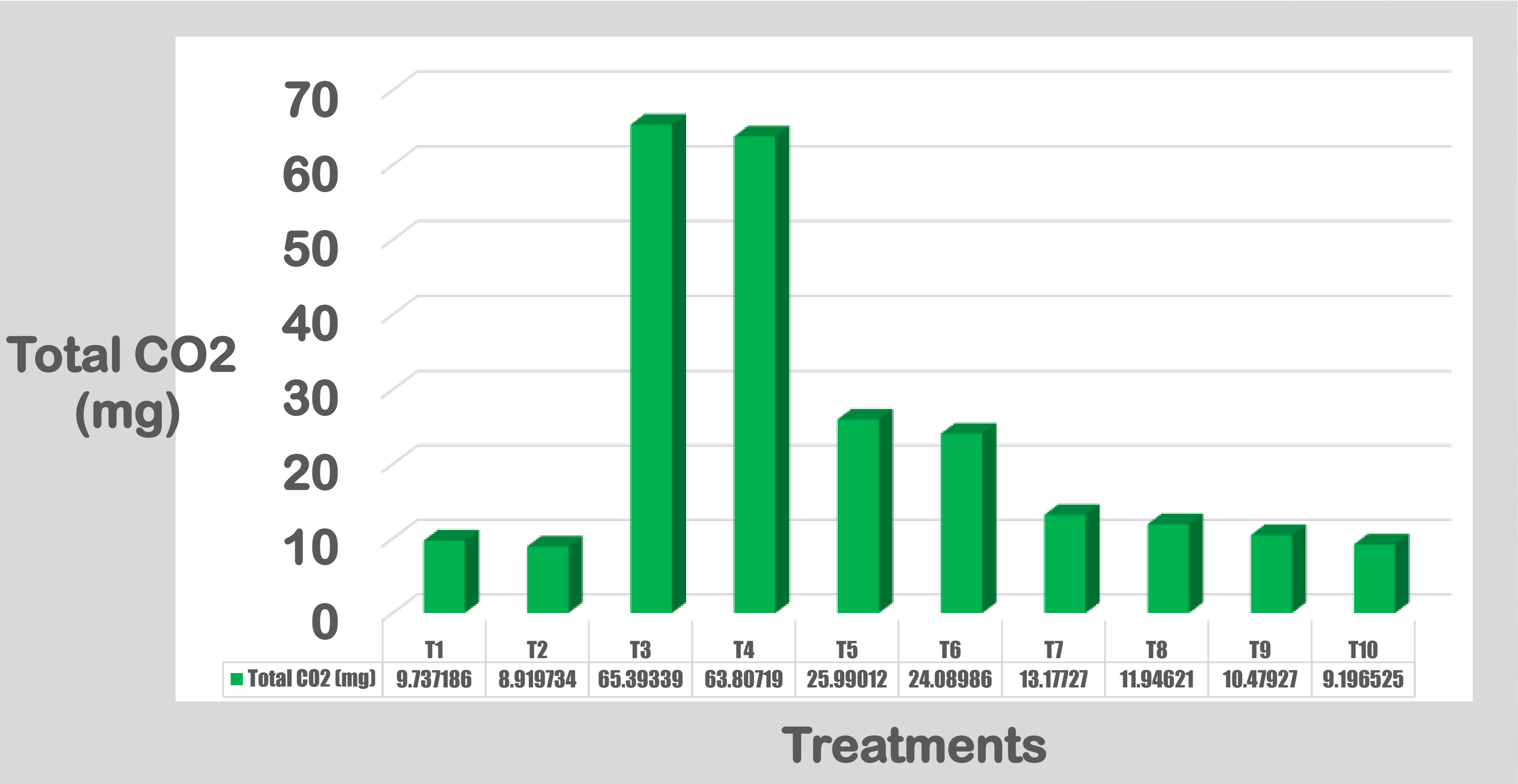


Results



Cumulative CO_2 evolution during the decomposition of organic materials with and without added biochar.

Results



Total CO_2 evolved after 28 days incubation period.

Results and Discussion

Results such as these showed that biochar addition can capture C into the soil even in short period of time and confirmed its use in the long term storage of atmospheric CO_2 that may mitigate or defer global warming.

Conclusion

The addition of biochar with organic and inorganic fertilizers in an acidic red soil showed a decrease of CO_2 evolution in the soil.

Findings such as these can be assumed that incorporated biochar helps to capture CO_2 when added into the soil.

Measurement of Carbon Dioxide in Corn Cob Biochar-amended Acid Soil Added with Different Types of Fertilizers