The Pharma Innovation Journal 2023; 12(12): 875-878

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 875-878

www.thepharmajournal.com
Received: 18-10-2023
Accepted: 28-11-2023

AC Pote
Punyashlok Ahilyadevi Holkar College of Agriculture, Halgaon, Maharashtra, India

PU Bhosale
Punyashlok Ahilyadevi Holkar College of Agriculture, Halgaon, Maharashtra, India

SA Anararse
Punyashlok Ahilyadevi Holkar College of Agriculture, Halgaon, Maharashtra, India

Corresponding Author:
AC Pote
Punyashlok Ahilyadevi Holkar College of Agriculture, Halgaon, Maharashtra, India

Impact of various biochar sources incubated with FYM on soil carbon pools and fodder maize yield

AC Pote, PU Bhosale and SA Anararse

Abstract
The field experiment, " Impact of various biochar sources incubated with FYM on soil carbon pools and fodder maize yield" was performed at the Post Graduate Institute's Research Farm, M.P.K.V., Rahuri's Instructional Farm in the Department of Soil Science and Agriculture Chemistry during the 2019–20 *kharif* season. Following their removal from the experimental area, the soil samples were examined for their initial chemical properties. The texture of the soil is clay loam. The soil had low, medium, and high available N, P, and K concentrations, in that order. There were three replications and seven treatments in the field trial, all of which were set up using a Randomized Block Design (RBD). Applying FYM incubated cotton stalk biochar greatly boosted fodder maize yield (50.63 t ha^{-1}), which was comparable to treatments T_5, T_7, T_6, and T_4 (48.51 t ha^{-1}, 46.26 t ha^{-1}, 46.23 t ha^{-1}, and 45.16 t ha^{-1}). In the absolute control treatment, the lowest yield of fodder maize (21.36 t ha^{-1}) was noticed.
Applying T_3 treatments (cotton stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1}) resulted in greater soil organic carbon (0.82%), which was comparable to T_7 (0.78%) treatments. In comparison to the control, the significantly greatest total organic carbon (1.23%) was comparable to T_5 (1.13%), T_7 (1.10%), and T_6 (1.09%). The application of T_3 treatments resulted in significantly higher soil microbial biomass carbon (219.6 mg kg^{-1}) for cotton stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1}). This was comparable to T5 treatments (208.1 mg kg^{-1}) for pigeon pea stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1}) and T_2, (195.2 mg kg^{-1}) GRDF (100:50:50 kg ha^{-1} + 5 t ha^{-1} FYM). The absolute control treatment revealed the lowest percentages of soil organic carbon (0.63%), overall organic carbon (0.95%), and microbial biomass in the soil carbon (131.9 mg kg^{-1}).

Keywords: Biochar, cotton stalk, fodder maize, soil carbon pools, POXc, Pomc, SMBC, WSC

Introduction
One of the most significant cereal crops in the world for use in food and feed is maize, or corn (*Zea mays* L.). Despite possessing a low protein content, animals prefer maize fodder as it is palatable and succulent (Ali *et al.* 2004) [1]. The livestock's output has significantly improved and this enterprise gets more profitable with the help of the maize fodder. The crop's versatility, superior fodder quality, and use as silage give it an advantage over farmed fodder crops. Due to its high albuminoidal and fat content, robust leafy growth, excellent palatability, and easy digestion, maize green fodder is a valuable cattle feed.
Since maize has a very high nutrient demand, a nutrient management method is crucial to its productivity. One of the first types of manure used by farmers to cultivate crops is FYM. 0.5% N, 0.2% P, and 0.5% K are present. It enhances the biological, chemical, and physical properties of the soil, consequently promoting crop development. With the primary objective of improving soil, biochar is a highly porous, finely grained, carbon-dominant product that is rich in paramagnetic centers of both organic and inorganic nature. It is produced by slow pyrolysis of biomass waste and has a large surface area with oxygen functional groups and aromatic surfaces (Amonette and Joseph, 2009) [2]. Adding biochar in conjunction with other organic amendments has proven to be a successful way for boosting crop production and soil fertility recently.
There are numerous agricultural wastes readily available that are not being used at the farm level, which makes them ideal for utilizing the technology. These wastes have the potential to be prepared and used to make biochar. These consist of maize stubbles, cotton stalks, and pigeon pea stalks, among others. Crop yields can be increased and soil carbon levels can be raised by adding biochar, that is generated from these wastes. Although the advantages of adding biochar to alkaline tropical soils are still unclear, some research indicates that biochar is quite successful in improving plant growth and yield in neutral and acidic soils along with enhancing soil nutritional availability.

Consequently, the current investigation was started the "Impact of various biochar sources incubated with FYM on soil carbon pools and fodder maize yield".

Materials and Methods

Over the 2019–20 kharif season, the field experiment had been carried out at the Post Graduate Institute Research Farm, Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. The experimental soil belonged to the Inceptisols order and was medium-deep black in color. At PGI, Farm, MPKV, Rahuri, biochar was made using the pyrolysis klin technique with the help of a brick and a metallic drum. Cotton stalks, pigeon pea stalks, sugarcane debris, sugarcane bagasse, and *Prosopis juliflora* wood were the materials used for making the biochar. Seven treatments and three replications were included in the randomized block design of the experiment. For dibbling, the fodder maize was sown at the prescribed spacing of 30 cm x 5 cm. The treatments are as follows: T_1 is the Absolute Control; T_2 is the GRDF (100:50:50 kg ha^{-1} N: P_2O_5: K_2O + 5 t ha^{-1} FYM); T_3 is the Cotton Stalk Biochar Incubated with FYM (1:1) (2.5:2.5 t ha^{-1}); T4 is the Sugarcane Trash Biochar Incubated with FYM (1:1) (2.5:2.5 t ha^{-1}); T5 is the Pigeonpea Stalk Biochar Incubated with FYM (1:1) (2.5:2.5 t ha^{-1}); T_6 is the Sugarcane Bagasse Biochar Incubated with FYM (1:1) (2.5:2.5 t ha^{-1}); T_7 is *Prosopis juliflora* (Vedi Babul) Biochar Incubated with FYM (1:1) (2.5:2.5 t ha^{-1}). Using a soil auger, samples of soil (0–15 cm deep) were taken at random to generate a composite sample that would be used to assess the fertility level both before and after harvest.

Results and Discussion

The outcomes indicated that, at the time of fodder maize harvest, FYM incubated biochar from various sources impacted the soil's carbon fractions, involving soil organic carbon, total organic carbon, soil microbial biomass carbon, water soluble carbon, particulate organic matter carbon, and potassium permanganate oxidizable organic carbon. These findings are shown in Tables 1 and 2.

Fodder Yield of Maize

Application of FYM incubated cotton stalk biochar significantly increased fodder maize yield (50.63 t ha^{-1}), which was comparable to treatments T_5, T_7, T_6, and T_4 (48.51 t ha^{-1}, 46.26 t ha^{-1}, 46.23 t ha^{-1}, and 45.16 t ha^{-1}). In the absolute control treatment, the lowest yield of fodder maize (21.36 t ha^{-1}) was observed. This could be the result of biochar's nutritional benefits in addition to the soil's improved chemical and physical characteristics. A higher yield of fodder maize was achieved through the use of biochar, FYM, and inorganic fertilizers to add more nutrients. The impact of biochar on soil physico-chemical properties, which include increased water holding capacity, increased cation exchange capacity, and providing a medium for plant nutrient absorption and congenial conditions to soil microorganisms, may be the cause of the increase in maize fodder yield in biochar applied pots (Gandahi *et al.* 2015) [17]. Chen *et al.* (2010) [18] reported that the yield of sugarcane was enhanced by the inorganic nitrogen present in biochar. The yield has been improved by the incorporation of nitrogenous fertilizers in addition to charcoal.

Soil Organic Carbon

Table 1 displays the data about how adding biochar affected the amount of organic carbon in the soil once fodder maize was harvested. Applying 1:1 ratio of FYM-incubated cotton stalk biochar resulted in a much higher value (0.82%) at harvest, comparable to the 0.78% application of FYM-incubated *Prosopis juliflora* biochar. FYM-incubated biochar of sugarcane bagasse and FYM-incubated biochar of pea stalk application are statistically equivalent (0.75% and 0.73%). Regarding their organic carbon, the remaining treatments were determined to be comparable to one another. The treatment that was the absolute control (0.63%) showed the lower results. The rise in soil organic carbon content observed in FYM incubated biochar made from *Prosopis juliflora* and cotton stalk may be related to the fact that both sources had higher levels of lignin in their organic matter, which enhanced the soil organic carbon content. According to Shenbagavalli and Mahimairaja (2012) [14] and Masto *et al.* (2013) [11], the soil may have been enhanced with organic carbon content due to the high carbon concentration in the biochar. The addition of biochar resulted in an increase in soil organic carbon, as noted by Timilsina *et al.* (2017) [15], Lehmann (2007) [9].

Total Organic Carbon

The FYM incubated biochar composed of cotton stalk, sugarcane trash, pigeon pea stalk, sugarcane bagasse, and *Prosopis juliflora* all of which are shown in Table 1 had a substantial impact on the total organic carbon content. In comparison to the control, the T3 treatment (cotton stalk biochar incubated with FYM in 1:1) showed the significantly greatest total organic carbon (1.23%), which was proportional to the T_5 (1.13%), T_7 (1.10%), and T_6 (1.09%) treatments. The total organic carbon in the soil increased by applying biochar in conjunction with FYM (Arun kumar *et al.* 2019) [3]. The carbon content of the FYM and biochar may be the reason of this.

Soil Microbial Biomass Carbon

Table 1 shows the results of FYM's incubated biochar of cotton stalk, pigeonpea stalk, bagasse, sugarcane trash, and *Prosopis juliflora* in a 1:1 ratio on soil microbial biomass carbon at fodder maize harvest. The soil microbial biomass carbon (219.6 mg kg^{-1}) recorded through the application of T_3 treatments (Cotton stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1}) was significantly higher than that of T_5 treatments (208.1 mg kg^{-1}) and T_2, (195.2 mg kg^{-1}) GRDF (100:50:50 kg ha^{-1} + 5 t ha^{-1} FYM) when compared to the absolute control. This might be due to the more active microbes, which break down more organic matter in the soil and liberate more labile organic carbon (Demisie *et al.* 2014) [8]. Since biochar increases the microbial population, as reported by Arun Kumar *et al.* (2019) [3], it increases the carbon level of the soil's microbial biomass. Microbial biomass carbon and the activity of enzymes increase with increased rates of carbon mineralization in biochar treatments (Ouyang *et al*. 2014) [12]. The rise in SMBC may result from the pores and vast surface area of the biochar particles, which may capture water molecules that stick to the particles (Azeem *et al.* 2018) [5].

Water Soluble Carbon

After the harvest of fodder maize, the results of water soluble carbon detected in the soil were statistically non significant.

The treatment FYM incubated biochar of sugarcane bagasse had the maximum water soluble carbon content, evaluated in terms of numbers (38 mg kg^{-1}).

Table 1: Effect of FYM incubated biochar of different sources on carbon fractions in soil at harvest of fodder maize

Tr. No.	Treatment	Yield (t ha^{-1})	Soil organic carbon (%)	Total organic carbon (%)	Soil microbial biomass carbon (mg kg^{-1})
T_1	Absolute control	21.36	0.63	0.95	131.9
T_2	GRDF (100:50:50 kg ha^{-1} $N:P_2O_5:K_2O$ + 5 t ha^{-1} FYM)	46.26	0.67	1.00	195.2
T_3	Cotton stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	50.63	0.82	1.23	219.6
T_4	Sugarcane trash biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	45.16	0.68	1.02	169.9
T_5	Pigeonpea stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	48.51	0.75	1.13	208.1
T_6	Sugarcane bagasse biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	46.23	0.73	1.09	161.1
T_7	*Prosopis juliflora* (Vedi Babul) biochar incubated with FYM(1:1) (2.5:2.5 t ha^{-1})	47.47	0.78	1.10	181.7
	S.E. $\pm$	2.53	0.019	0.06	10.73
	C.D. at 5%	7.80	0.059	0.19	33.06

Particulate Organic Matter Carbon

Table 2 shows the data concerning the application of biochar on fodder maize. The addition of FYM-incubated biochar composed of cotton stalk, sugarcane debris, pigeon pea stalk, sugarcane bagasse, and Prosopis juliflora had an impact on the particulate organic matter carbon. After the harvest of fodder maize, treatment T_3, FYM incubated biochar of cotton stalk (1.73 mg kg^{-1}) had the highest particulate organic matter carbon content. This was statistically comparable to treatment T_5, FYM incubated biochar of pigeon pea stalk (1.56 mg kg^{-1}), and treatment T_7 (1.50 mg kg^{-1}). The biochar particles caused an increase in particulate organic matter carbon yield and organic carbon storage, which most likely altered this fraction's ecological role in the soil (Cooper *et al.* 2020) [7].

Potassium Permanganate Oxidizable Organic Carbon

When fodder maize was harvested, the amount of oxidizable organic carbon in the soil which had been determined was statistically non-significant. The treatment FYM incubated biochar of cotton and pigeon pea stalks has the highest potassium permanganate oxidizable organic carbon content (1.74 mg kg^{-1}). The most easily decomposable or labile carbon is the organic carbon that can be oxidized by potassium permanganate; the results are consistent with the findings of Blair *et al.* (1995) [6]. This procedure is related to the oxidative process that occurs in the microbial breakdown of organic matter in soil and is based on the oxidation activity of $KMnO_4$ under neutral conditions.

Table 2: Effect of FYM incubated biochar of different sources on carbon fractions in soil at harvest of fodder maize

Tr. No.	Treatment	Water soluble carbon (mg kg^{-1})	Particulate organic matter carbon (mg kg^{-1})	Potassium permanganate oxidizable organic carbon (mg kg^{-1})
T_1	Absolute control	18	0.89	1.70
T_2	GRDF (100:50:50 kg ha^{-1} $N:P_2O_5:K_2O$ + 5 t ha^{-1} FYM)	32	1.03	1.71
T_3	Cotton stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	36	1.73	1.74
T_4	Sugarcane trash biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	34	1.06	1.73
T_5	Pigeonpea stalk biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	33	1.56	1.74
T_6	Sugarcane bagasse biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	38	1.26	1.72
T_7	*Prosopis juliflora* (Vedi Babul) biochar incubated with FYM (1:1) (2.5:2.5 t ha^{-1})	32	1.50	1.72
	S.E. $\pm$	2.68	0.09	0.1
	C.D. at 5%	NS	0.27	NS

Conclusions

With regard to soil organic carbon (0.82%), total organic carbon (1.23%), soil microbial biomass carbon (219.61 mg kg^{-1}), particulate organic matter carbon (1.73 mg kg^{-1}), and the fodder yield (50.63 t ha^{-1}), the treatment of cotton stalk biochar incubated with FYM was found to be significantly superior to all other treatments. In accordance to the outcomes of this investigation, the treatment that received cotton stalk biochar incubated with FYM was found to be significantly better than any other approach. It additionally enhanced the soil carbon fractions, including particulate organic matter, soil microbial biomass carbon, soil organic carbon, and soil organic carbon, and it increased the yield of fodder maize in Inceptisols.

References

1. Ali Z, Hassan MZ, Khan S, Bashir M. Cost benefit analysis of wheat, barley, oat and mustard crops for fodder production. Sarhad Journal of Agriculture. 2004;20(4):669-671.
2. Amonette JE, Joseph S. Characteristics of biochar: micro chemical properties. Chapter 3: In: Lehmann, J., Joseph, S. (Eds) Biochar for environmental management science and technology. Earth Scan, London; c2009. p. 33-52.
3. Arunkumar BR, Thippeshappa GN, Chidanandappa HM, Gurumurthy KT, Basavaraj NT, Basavarajappa HB. Effects of biochar on soil carbon pools under aerobic rice cultivation. Journal of Pharmacognosy and Phytochemistry. 2019;8(4):1398-1402.
4. Atkinson CJ, Fitzgerald JD, Hipps NA. Potential mechanisms for achieving agricultural benefits from biochar application to temperate soils: A review. Plant and Soil. 2010;337(1):1-18.
5. Azeem M, Hayat R, Hussain Q, Ahmed M, Imran M,

Crowley DE. Effect of biochar amendment on soil microbial biomass, abundance and enzyme activity in the mash bean field. Journal of Biodiversity and Environmental Sciences. 2018;8(6):1-13.
6. Blair G, Lefroy R, Lisle L. Soil carbon fractions based on their degree of oxidation, and the development of a carbon management index for agricultural systems. Australian Journal of Agriculture Research. 1995;46:1459-1466.
7. Coopeer J, Greenberg I, Ludwig B, Hippich L, Fischer D, Glaser B, *et al*. Effect of biochar and compost on soil properties and organic matter in aggregate size fractions under field conditions. Agriculture, Ecosystem and Environment. 2020;295:1-9.
8. Demisie W, Liu Z, Zhang M. Effect of biochar on carbon fractions and enzyme activity of red soil. Catena. 2014;121:214-221.
9. Lehmann J. A handful of carbon. Nature. 2007;447:143-144.
10. Lehmann J, Gaunt J, Rondon M. Biochar sequestration in terrestrial ecosystems: A review. Mitigation and Adaptation Strategies for Global Change. 2006;11(2):395-419.
11. Masto RE, Ansari Md A, George J, Selvi VA, Ram LC. Co-application of biochar and lignite fly ash on soil nutrient and biological parameters at different growth stages of *Zea mays*. Ecological Engineering. 2013;58:314-322.
12. Ouyang L, Tang Q, Yu L, Zhang R. Effect of amendment of different biochar on soil enzyme activities related to carbon mineralization. Soil Research. 2014;52:706-716.
13. Qayyum MF, Steffens D, Reisenauer HP, Schubert S. Biochars influence differential distribution and chemical composition of soil organic matter. Plant Soil Environment. 2014;60:337-343.
14. Shenbagavalli S, Mahimairaja S. Characterization and effect of biochar on nitrogen and carbon dynamics in soil. International Journal of Advanced Biological Research. 2012;2(2):249-255.
15. Timilsina S, Khanal BR, Shah SC, Shrivastav CP, Khanal A. Effects of biochar application on soil properties and production of radish (*Raphanus sativus* L.)on loamy sand soil. Journal of Agriculture and Forestry University. 2017;1:103-111.
16. Venkatesh G, Reddy SK, Gopinath KA, Kumari VV, Chary RG. Biochar for enhancing the soil, water and crop productivity inrainfed areas. In: Krishna Rao, B., Sammi Reddy, K., VishaKumari, V., Nagarjunakumar, R. and Rejani, R. (eds.). Rainwater Management for Climate Resilient Agriculture in Drylands; c2018. p. 523.
17. Sohu I, Gandahi AW, Bhutto GR, Sarki MS, Gandahi R. Growth and Yield Maximization of Chickpea (*Cicer arietinum*) Through Integrated Nutrient Management Applied to Rice-Chickpea Cropping System. Sarhad Journal of Agriculture. 2015 Jun 30;31(2):131-138.
18. Gao T, Yao H, Song J, Liu C, Zhu Y, Chen S. Identification of medicinal plants in the family Fabaceae using a potential DNA barcode ITS2. Journal of ethnopharmacology. 2010 Jul 6;130(1):116-121.