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Efficacy of Characterized Tender Coconut Husk Biochar Amendment to Improve Biometric Characters and Yield of Yard Long Bean

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ABSTRACT

Biochar is a carbon rich material produced by the pyrolysis of organic crop residues. Its application has been found to improve biometric characters and yield of crops by improving physical and chemical properties of the soil. It can act as a tool to sequester carbon dioxide that would otherwise be released to the atmosphere through the decomposition or burning of organic residues. Considering the benefits of biochar in crop production, a field experiment was conducted at College of Agriculture, Vellayani of Kerala Agricultural University to investigate the efficacy of biochar from tender coconut husk for enhanced crop production in acidic ferralitic soil. Biochar, produced from tender coconut husk was characterized and tested in the field at different levels of application *viz.* 10 and 20 and 30 t/ha using yard long bean variety Vellayani Jyothika as the test crop. Along with biochar, other commonly used organic manures *viz*. Farm yard manure and vermicompost; biofertilizers *viz.* Plant Growth Promoting Rhizobacteria (PGPR) and Arbuscular Mycorrhizal Fungi (AMF) were also tested in the field. The experiment was laid out in RBD with 9 treatments and 3 replications. Application of biochar @ 20 t/ha along with 2 per cent PGPR and NPK as per POP significantly increased yield (20.12 t/ha), days to fifty per cent flowering (35), no of nodules per plant (18), weight of nodules per plant (1.65g), no of leaves per plant (39), vine length (517.50 cm), pod length (52.80 cm) and other yield attributing characters and finally the Benefit Cost Ratio (1.56).

Key Words: Biochar, Biometric characters, Coconut husk, Yard londg bean, Yield.

INTRODUCTION

Food security, declining soil fertility, climate change and profitability are the major issues faced by human population which act as the driving force behind the introduction of new technologies in agriculture. Conversion of organic biomass into biochar and its use as a soil amendment is a novel approach. Biochar is a fine-grained, carbon-rich product obtained by the thermal decomposition of organic material under zero or limited supply of oxygen, and at relatively low temperatures (<700°C) by the process of pyrolysis (Lehmann, 2007). There are two aspects which make biochar amendment superior to other organic materials: the first is its high stability against decay, so that it can remain in soil for longer period providing long-term benefits to soil and the second is having more capability to retain the nutrients. It has great importance in improving soil fertility, crop growth and yield, as it can act as a soil amendment by increasing soil pH, supplying and retaining nutrients than other organic matter such as leaf litter, compost or manure. Highly porous nature of biochar increases its surface area to adsorb and release water and nutrients to plants as well as keep carbon intact without releasing to the atmosphere (Atkinson *et al*, 2010).

Production of biochar from crop residues is a technique for waste management also. Tender coconut water is one of the best refreshing natural health drink. However, disposal of tender coconut husk, which is a major biowaste that accumulates along the road sides in Kerala is a burden for

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vendors as well as authorities. The best way to utilize it for crop production without causing environmental pollution is by converting it to a nutrient rich soil amendment, biochar. Improved physical, chemical and biological properties of soil by biochar application results in better biometric properties that ultimately leads to better yield and economic returns. Biochar can improve biometric characters and crop performance directly as a result of its nutrient content and release characteristics; indirectly by improved retention of nutrients (Lehmann *et al*, 2003), improvements in soil pH (Rondon *et al*, 2007), increased soil Cation Exchange Capacity (Liang *et al*, 2006), improved soil physical properties (Chan *et al*, 2008) and alteration of soil microbial populations and functions (Pietikainen *et al*, 2000). Soil productivity and plant growth can be maximized when biochar is applied with inorganic or organic fertilizer (Hussain *et al*, 2017). Present study was the first attempt in Kerala to produce biochar from tender coconut husk for its characterization and utilization of it as soil amendment for yield increase in yard long bean ((*Vigna unguiculata var. sesquipedalis).*

MATERIALS AND METHODS

Taking the beneficial effects of biochar into consideration, a field experiment was conducted at College of Agriculture, Vellayani of Kerala Agricultural University, to investigate the efficacy of biochar from tender coconut husk for enhanced crop production. Biochar was produced from tender coconut husk, characterized and tested in the field at different levels of application *viz.* 10 and 20 and 30 t/ha using yard long bean variety Vellayani Jyothika as the test crop. The soils of the experimental site belong to the family of Loamy Skeletal Kaolinitic Isohyperthermic Rhodic Haplustult. The tender coconut husk biochar produced was having an alkaline pH (9.13) with Cation Exchange Capacity of 15.26 cmol/kg, Water Holding Capacity of 226.00 per cent, bulk density of 0.14 Mg/m^3 and BET surface area of 157.93 m^2/g. Along with biochar, other commonly used organic manures *viz.* Farm Yard Manure and vermicompost; biofertilizers *viz.* PGPR and AMF were also tested in the field. It was an RBD with 9 treatments and 3 replications. The treatments were 1. Package of Practices recommendation 2. Biochar @ 10 t/ha + NPK as per POP, 3. Biochar @ 20 t/ha + NPK as per POP, 4. Biochar @ 30 t/ha + NPK as per POP, 5. Biochar @ 20 t/ha + 75% NPK as per POP, 6. Biochar @ 10 t/ha + FYM @ 10 t/ha +75% NPK as per POP, 7. Biochar @ 10 t/ha + vermicompost @ 5 t/ha + 75% NPK as per POP, 8. Biochar @ 20 t/ha + 2 % PGPR + NPK as per POP, 9. Biochar @ 20 t/ha + AMF @ 200 g/m^2 + NPK as per POP. Biometric observations *viz*. days to fifty per cent flowering, days from flowering to final harvest, weight of nodules per plant, vine length and number of leaves per plant were taken and analyzed statistically. Data from the field experiment was statistically analyzed using ANOVA.

RESULTS AND DISCUSSION

Biometric characters

Biochar application had significant influence on days to fifty per cent flowering and crop duration. In the present study, application of biochar @ 20 t/ha along with 2 per cent PGPR and NPK as per POP resulted in earliest flowering. This is due to the fact that biochar application resulted in an increased plant growth by the supply of nutrients contained in it as well as by increasing the nutrient use efficiency of applied fertilizers resulting in better metabolic partitioning. This helps the plant in reaching the reproductive stage earlier. A prolonged reproductive period was also noticed for the same treatment in which biochar was applied @ 20 t/ha along with 2 per cent PGPR and NPK as per POP. Treatment that received POP took comparatively more days for fifty percent flowering with shorter reproductive period.

The significantly superior vine length (517.50 cm) and number of leaves (240) per plant were registered by the treatment that received biochar @ 20 t/ha along with 2 per cent PGPR and NPK as per

Table 1. Effect of treatments on biometric characters of yard long bean

Treatment	Days to fifty per cent flowering	Duration from flowering to final harvest (days)	Number of nodules / plant	Weight of nodules / plant (g)	Vine length (cm)	Number of leaves per plant
T_1	41	60	4	0.23	420.50	192
T_2	40	66	6	0.35	460.00	210
T_3	35	73	10	0.76	486.50	220
T_4	34	79	17	1.50	509.50	232
T_5	36	72	8	0.53	483.00	216
T_6	36	71	8	0.43	478.90	213
T_7	35	76	11	0.98	495.00	225
T_8	33	81	18	1.95	517.50	240
T_9	35	76	12	1.34	501.50	228
CD (0.05)	2.706	3.118	1.988	0.098	5.335	1.999

POP. Biometric characters were greatly influenced by the progressive additions of biochar @10 t/ha to 30 t/ha, when it was applied with NPK as per POP. The results are in conformity with that obtained by Southavong *et al,* (2012) who reported that application of rice husk biochar to soil @ 40 t/ha increased plant height, number of leaves per plant, leaf width and foliage yield of water spinach (18.10 t/ha).

From the experimental results, it can be realized that biochar application had significant influence on nodule formation (number and weight of nodules per plant) in yard long bean. Among the treatments, biochar @ 20 t/ha + 2 per cent PGPR + NPK as per POP recorded significantly superior value of 18 nodules per plant and it was on par with the treatment that received biochar @ 30 t/ha+ NPK as per POP. The increased nodulation can be related with the fact that Rhizobia functions well in soils with neutral pH and hence increasing pH acidic soil by biochar amendment enhances nodulation and fixation. Both biochar and PGPR had contributed significantly for the multiplication of Rhizobium. The rhizobial population was able to derive large amount of metabolic fuel from the actively growing plants that resulted in better nodulation. The root exudates helped in buildup of beneficial microbial population by biochar into the rhizosphere of the plant. Thus, the micro-environment created by the interaction between chemicals secreted by living roots and microorganisms in the rhizosphere positively influenced root growth and thereby nodulation (Rondon *et al*, 2007). He reported that there was positive influence in nodulation by the progressive additions of biochar @10 t/ha to 30 t/ha along with NPK in yard long bean.

Yield, yield attributes and benefit-cost ratio

Yield and yield attributing characters of yard long bean were significantly enhanced by the application of biochar. The significantly superior yield of 20.12 t/ha was registered by the treatment T_8 to which biochar was applied @ 20 t/ha along with 2 per cent PGPR and NPK as per POP. There observed a yield increase by 54.32 per cent. It was the most economically viable treatment with highest benefit cost ratio of 1.56. Treatment that received POP recorded the lowest yield of 13.04 t/ha. Yield and yield attributing characters increased progressively as the levels of biochar increased from 10 to 30 t/ha when it was applied with NPK. As a result of biochar application, there observed an improvement in pod length by 20.31 per cent (54.50 cm), pod girth by 36.84 per cent (3.90 cm), mean

Table 2. Effect of treatments on yield, yield attributes and benefit-cost ratio in yard long bean

Treatment	Pod length (cm)	Pod girth (cm)	Mean pod weight (g)	Pods plant^{-1}	Pod yield (t/ha)	BCR
T_1	45.30	2.10	22.56	39	13.04	1.20
T_2	48.20	2.60	25.45	44	16.59	1.31
T_3	50.50	3.20	25.68	47	17.88	1.36
T_4	52.80	3.70	25.76	49	18.70	1.46
T_5	49.80	2.90	25.83	46	17.60	1.35
T_6	48.60	2.90	25.38	45	16.92	1.43
T_7	51.70	3.00	25.87	47	18.02	1.42
T_8	54.50	3.90	26.63	51	20.12	1.56
T_9	52.60	3.40	25.73	48	18.30	1.24
CD (0.05)	0.769	0.231	0.982	1.332	0.260	0.085

pod weight by 18.04 per cent (26.63 g) and number of pods per plant by 30.77 per cent (51), compared to the control treatment that had not received biochar. Steiner *et al*, (2007) reported an increase of maize grain yield by 50 per cent when biochar was applied @11 t/ha with mineral fertilizer @ 85 kg N/ha in a highly weathered Xanthic Ferralsol. Hussain *et al*, (2017) also reported that soil productivity and plant growth can be maximized when biochar is applied with inorganic or organic fertilizer.

The higher yield of plants observed during the experiment by biochar application could be assigned to the increased soil pH as a result of liming effect, improved water holding capacity, increased cation exchange capacity, enhanced biological N fixation and reduced bulk density of soil. High surface area of biochar provides a medium for adsorption of plant nutrients resulting in enhanced nutrient uptake by plants and improved conditions for the multiplication and activity of soil micro-organisms. A liming effect of biochar has been suggested as one of the likely reasons for improved crop yields on acidic soils (Verheijen *et al*, 2010). Lehmann (2007) also stressed that soil nutrients are retained and remain available to plant due to the application of biochar hence it increased crop yield. Moreover, it resulted in better uptake of nutrients, better partitioning of photosynthates, enhanced pod length, pod girth, number of pods per plant and finally the pod yield. The synergistic effect of biochar and mineral fertilizer is thought to be the result of increased plant nutrient uptake and improved availability of cationic nutrients such as P, K, Ca and Cu (Lehmann *et al*, 2003). In addition to this, application of PGPR had also played significant role in improving growth and yield of yard long bean. Yield increase obtained in PGPR applied plants could be attributed to the production of plant growth promoting substances produced by root colonizing bacteria (Kennedy and Tchan, 1992). These might be responsible for well-developed root system and enhanced nutrient and water uptake, thereby overall improvement in yield.

CONCLUSION

From the investigations, it can be concluded that application of biochar @ 20 t/ha along with 2 per cent PGPR and NPK as per POP which resulted in the yield of 20.12 t/ha can be considered as the economically viable and the best treatment. Biochar from tender coconut husk can be used as a good soil amendment which can improve soil health and enhance crop production. Conversion of biomass to biochar is a cost-effective way for management of tender coconut husk waste. Biochar is a rich source of carbon and all the essential plant nutrients,

efficient releaser and adsorber of nutrients, a potential tool for carbon sequestration and finally a best soil amendment which can improve physical, chemical and biological properties of soil to a great extent and crop yield.

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