INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-6, Issue-2, April-June-2016 Coden: IJPAJX-CAS-USA, Copyrights@2016 ISSN-2231-4490
Received: 15th Feb-2016 *Revised: 15th Mar 2016* *Accepted: 16th Mar 2016*
Research article

EFFICACY OF BIOCHAR FROM TENDER COCONUT HUSK ON YIELD OF YARD LONG BEAN IN FERRALITIC SOILS

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ABSTRACT: An 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, characterized and tested in the field at different levels of application *viz*. 10 and 20 and 30 t ha^{-1} using yard long bean variety Vellayani Jyothika as the test crop during January 2013 to April 2013. Along with biochar, other commonly used organic manures *viz*. Farm yard manure and vermicompost; biofertilizers namely Plant Growth Promoting Rhizobacteria (PGPR) and Arbuscular Mycorrhizal Fungi (AMF) were also tested in the field. The experiments were laid out in Randomized Block Design with three replications. The treatments were 1. Package of Practices recommendation (POP), 2. Biochar @ 10 t ha^{-1} + NPK as per POP, 3. Biochar @ 20 t ha^{-1} + NPK as per POP, 4. Biochar @ 30 t ha^{-1} + NPK as per POP, 5. Biochar @ 20 t ha^{-1} + 75 % NPK as per POP, 6. Biochar @ 10 t ha^{-1} + FYM @ 10 t ha^{-1} + 75 % NPK as per POP, 7. Biochar @ 10 t ha^{-1} + vermicompost @ 5 tha^{-1} + 75% NPK as per POP, 8. Biochar @ 20 t ha^{-1} + 2 % PGPR + NPK as per POP 9. Biochar @ 20 t ha^{-1} + AMF @ 200 g m^{-2} + NPK as per POP. Biochar application @ 20 t ha^{-1} along with 2 % PGPR and NPK as per POP resulted in better total dry matter production (TDM), pod protein, Harvest Index (HI) and finally B: C ratio and pod yield.
Key words: Biochar, Coconut husk, Ferralitic soils

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INTRODUCTION

Biochar is the 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 [1]. Biochar has great importance in improving soil fertility and it can act as a soil amendment to increase crop yield and plant growth by supplying and retaining nutrients than other organic matter such as leaf litter, compost or manure. Tender coconut husk is a biowaste which accumulates on the road sides. The best way to utilize it for crop production without environmental pollution is by converting it to biochar. The beneficial effects of biochar on soil properties have been reported by many scientists and includes chemical [2], physical and biological changes in soil [3]. Application of biochar to soil can substantially improve the productivity of crops such as maize, soybean, radish, sorghum, potato, wheat, pea, oats, rice, and [4].

MATERIALS AND METHODS

Taking all the above beneficial effects of biochar into consideration, an 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^{-1} using yard long bean variety Vellayani Jyothika as the test crop during January to April 2013. Along with biochar, other commonly used organic manures (Farm yard manure and vermicompost) and biofertilizers (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^{-1} + NPK as per POP, 3. Biochar @ 20 t ha^{-1} + NPK as per POP, 4. Biochar @ 30 t ha^{-1} + NPK as per POP, 5. Biochar @ 20 t ha^{-1} + 75% NPK as per POP, 6. Biochar @ 10 t ha^{-1} + FYM @ 10 t ha^{-1}+75% NPK as per POP, 7. Biochar @ 10 t ha^{-1} + vermicompost @ 5 tha^{-1} + 75% NPK as per POP, 8. Biochar @ 20 t ha^{-1} + 2 % PGPR + NPK as per POP, 9. Biochar @ 20 t ha^{-1} + AMF @ 200 g m^{-2} + NPK as per POP. The soils of the experimental site belong to the family of Loamy Skeletal Kaolinitic Isohyperthermic Rhodic Haplustult. Observations were taken for pod yield and TDM production. Harvest index, B: C ratio and pod protein content were also estimated and the data was statistically analyzed.

RESULTS AND DISCUSSION

The results on the effect of biochar application on pod yield, TDM production, pod protein content, harvest index and B: C ratio of yard long bean is presented in Table 1. Biochar application significantly enhanced the pod yield, TDM production, pod protein content, harvest index and B: C ratio in yard long bean . When biochar was applied @ 20 t ha^{-1} along with 2 per cent PGPR and NPK as per POP, the yield was increased by 54.32 per cent, compared to the control treatment and the yield obtained was 20.12 t ha^{-1}, whereas the treatment that received POP (control) recorded the lowest yield of 13.04 t ha^{-1}. Application of biochar @ 10 t ha^{-1} along with NPK increased the crop yield by 43.40 per cent (18.70 t ha^{-1}), compared to the control treatment (Fig. 1). There was progressive increase in yield and related properties as the levels of biochar increased from 10 to 30 t ha^{-1} when it was applied with NPK. Treatment that received biochar @ 20 t ha^{-1} + 2 per cent PGPR + NPK as per POP showed an enhancement in yield by 12.51 per cent, compared to the the treatment that received biochar @ 20 t ha^{-1} along with NPK as per POP.

Table 1. Effect of treatments on pod yield, TDM, Harvest Index, B: C ratio and pod protein of yard long bean

Treatments	Pod yield t ha^{-1}	TDM (kg ha^{-1})	Harvest Index	B: C ratio	Pod protein (per cent)
T_1	13.04	2465.81	0.63	1.20	14.38
T_2	16.59	2936.93	0.68	1.31	16.00
T_3	17.88	3121.82	0.69	1.36	17.13
T_4	18.70	3278.26	0.68	1.46	20.00
T_5	17.60	3079.15	0.69	1.35	16.69
T_6	16.92	2986.70	0.68	1.43	16.25
T_7	18.02	3144.93	0.69	1.42	18.75
T_8	20.12	3498.71	0.69	1.56	21.44
T_9	18.30	3198.26	0.69	1.24	19.75
CD (0.05)	0.260	129.303	0.032	0.085	0.326

T_1 Biochar @ 1 per cent
T_2 Biochar @ 2 per cent
T_3 Farmyard Manure @ 1 per cent
T_4 Farmyard Manure @ 2 per cent
T_5 Vermicompost @ 1 per cent
T_6 Vermicompost @ 2 per cent
T_7 Control (no amendments)

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 CEC, enhanced biological nitrogen fixation, reduced leaching loss of nutrients especially N in to the ground water, reduced bulk density of soil and its high surface area providing a medium for adsorption of plant nutrients. Moreover, it resulted in better uptake of nutrients, better partitioning of photosynthates 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 [5]. Improved crop yields have also been attributed to a 'fertilizer effect' of added biochar supplying all the essential plant nutrients. [6] reported an increase of maize grain yield by 50 per cent relative to a fertilized control when 11 t ha^{-1} of biochar plus 85 kg N ha^{-1} of mineral fertilizer were applied to a highly weathered Xanthic Ferralsol. [7] reported that addition of wheat straw biochar @ 2.50 per cent led to about 20 to 30 per cent increase in grain yield compared with the use of the mineral fertilizer alone.

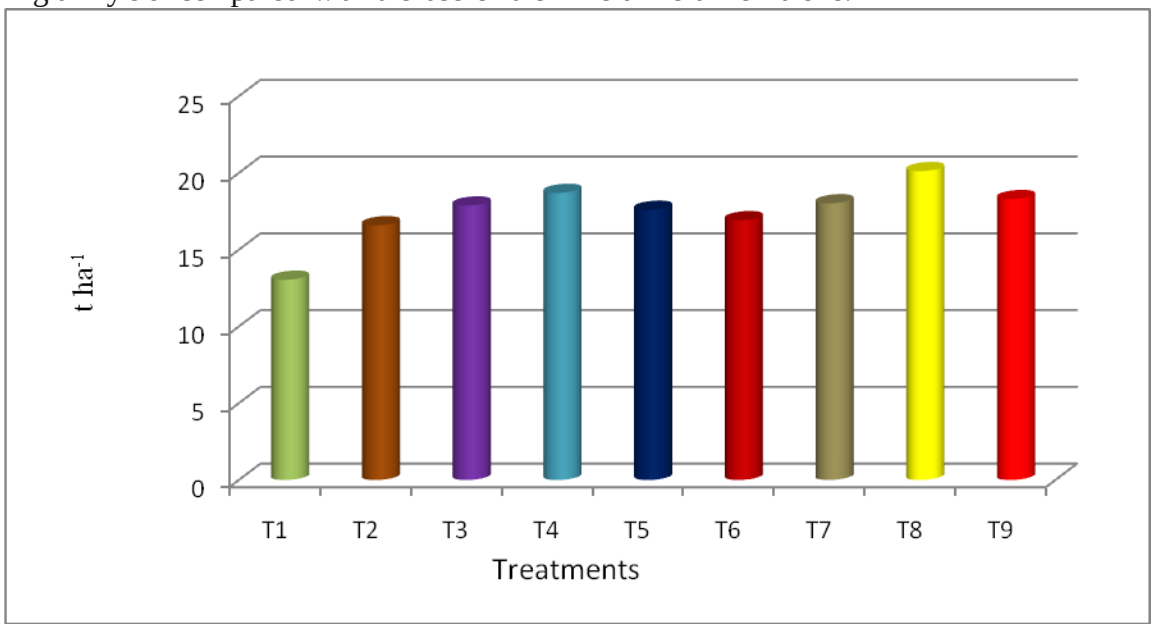

Fig. 1. Effect of treatments on yield of yard long bean

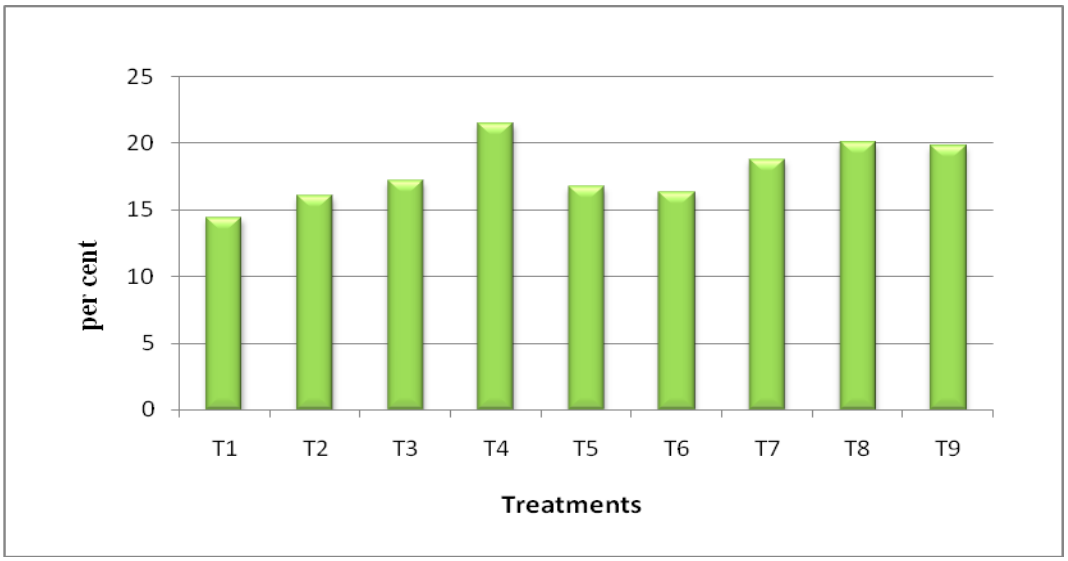

Fig. 2. Effect of treatments on pod protein content

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 inoculated plants could be attributed to the production of plant growth promoting substances produced by root colonizing bacteria [8]. These might be responsible for well developed root system and enhanced nutrient and water uptake, thereby overall promotion of yield. The results of the present study are in close conformity with those reported by [9]who conducted a pot culture experiment to study the impact of addition of biochar along with *Bacillus* sp. on growth and yield of french beans, and observed that addition of biochar @ 15 g kg^{-1} of soil along with commercial biofertilizer (Biozyme) resulted in obtaining the highest TDM and yield in the treatment consisting of soil, biochar and *Bacillus* sp. as compared to that of uninoculated control.

TDM, Harvest Index, B: C ratio and pod protein content were also significantly superior for the treatment that recorded the highest yield. TDM production was profoundly improved by 51. 36 per cent when biochar was applied @ 20 t ha^{-1} + 2 per cent PGPR + NPK as per POP which recorded significantly superior TDM production (3498.71 kg ha^{-1}), followed by biochar @ 30 t ha^{-1} + NPK as per POP and the treatment which received POP recorded the least value. These results are in conformity with the results obtained by [10] who found out that application of 30 t biochar ha^{-1} combined with annual fertilization of 122 kg N ha^{-1} resulted in 21 per cent dry matter increase in wheat. The better availability, uptake and assimilation of nutrients facilitated by biochar increased the vegetative growth and thus resulted in increased dry matter production also.

Harvest Index was found to be increased by 15.79 per cent by biochar application (0.69). [11] also reported that biochar application @ 20 t ha^{-1} improved the HI in wheat.

The experimental results revealed that the highest crude protein in pod was recorded by the treatment that received biochar @ 20 t ha^{-1} + 2 per cent PGPR + NPK as per POP, followed by the treatment to which biochar was applied @ 30 t ha^{-1}+ NPK as per POP). There observed an increase by 54.67 per cent in pod protein content, compared to POP (Fig. 2). The better nodulation facilitated by biochar application might have promoted better uptake, accumulation and assimilation of N in plant parts especially in pods and hence increased dry matter production and the N content in pod. The aminoacid production and protein formation also might have been raised. All these favorably influenced the pod protein content also by the application of biochar.

CONCLUSION AND RECOMMENDATION

The overall results of the present study indicate that application of biochar @ 20 t ha^{-1} along with 2 per cent PGPR and NPK as per POP recorded the significantly superior yield of 20.12 t ha^{-1} with B: C ratio of 1.56 and it can be considered as the economically viable and the best treatment. Hence, it is proved that biochar is one of the best soil amendments for enhanced crop production.

ACKNOWLEDGEMENT

I am thankful to Kerala State Council for Science, Technology and Environment, Thiruvananthapuram for providing fellowship grant for my Ph. D. programme.

REFERENCES

[1] Lehmann, J. 2007. A Handful of Carbon. Nature. 447, pp. 143–144.

[2] Yamato, M., Okimori, Y., Wibowo, I.F., Anshori, S., and Ogawa, M. 2006. Effects of the application of charred bark of Acacia mangium on the yield of maize, cowpea and peanut, and soil chemical properties in South Sumatra, Indonesia. Soil Sci. Pl. Nutr. 52, pp. 489.

[3] Rondon, M. A., Lehmann, J., Ramirez, J., and Hurtado, M. 2007. Biological nitrogen fixation by common beans (*Phaseolus vulgaris* L.) increases with bio-char additions. Biol. Fertil. Soils. 43, pp. 699-708.

[4] Lehmann, J., da Silva, J. P., Steiner, C., Nehls, T., Zech, W., and Glaser, B. 2003. Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol in the Central Amazon basin: Fertiliser, manure and charcoal amendments. Pl. Soil. 249, pp. 343-357.

[5] Verheijen, F. G. A., Jeffery, S., Bastos, A. C., van der Velde, M., and Diafas, I. 2010. Biochar application to soils - A critical scientific review of effects on soil properties, processes and functions. Rep. EUR 24099 EN. Office for the Official Publications of the European Communities, Luxembourg. Available online [12-March-2013]

[6] Steiner, C., de Arruda, M. R., Teixeira, W. G., and Zech, W. 2007. Soil respiration curves as soil fertility indicators in perennial central Amazonian plantations treated with charcoal, and mineral or organic fertilizers. Trop. Sci. 47, pp. 218-230.

[7] Alburquerque, J. A., Salazar, P., Torrent, J., Campillo, M. C., Gallardo, A., and Villar, R. M. 2013. Enhanced wheat yield by biochar addition under different mineral fertilization levels. Agron. Sustain. Dev. 33, pp. 475–484.

[8] Kennedy, I. R. and Tchan, Y. T. 1992. Biological nitrogen fixation in non-leguminous fieldcrops. Recent Adv. Pl. Soil. 141, pp. 93–118.

[9] Saxena, J., Rana, G., and Pandey, M. 2013. Impact of addition of biochar along with Bacillus sp. on growth and yield of French beans. Scientia Horticulturae. 162, pp. 351–356.

[10] Vaccari, F. P., Baronti, S., Lugato, E., Genesio, L., Castaldi, S., Fornasier, F. and Miglietta, F. 2011. Biochar as a strategy to sequester carbon and increase yield in durum wheat. European J. Agron. 34, pp. 231-238.

[11] Major, J., Rondon, M., Molina, D., Riha, S. J., and Lehmann, J. 2010. Maize yield and nutrition during 4 years after biochar application to a Colombian savanna oxisol. Pl. Soil. 333, pp.117-128.

INTERNATIONAL JOURNAL OF
PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

ISSN 2231-4490

International Journal of Plant, Animal and Environmental Sciences