Effects of Compost, Biochar, and Inorganic Fertilizer Combinations on the Growth and Yield of Bushita Bean (Vigna unguiculata)

W.G.U. Indeewara*, D. Nanayakkara, S. L. Ranamukhaarachchi

Sri Lanka Technological Campus (SLTC Research University), Padukka 10500, Sri Lanka

* udesh217@gmail.com

Abstract - Soil organic matter (SOM) is a critical component of soil management to support the growth and development of crops. Compost and biochar are popular soil amendments used to enhance the SOM content. The current study was conducted to determine the contribution of biochar in raising the growth and pod yield of bushita beans and the benefits of supplementing with inorganic fertilizers. The experiment was conducted in a farmer's field at Vitharandeniya in the district of Hambantota, Sri Lanka from February to May 2022. Six soil amendment levels and two fertilizer management levels were tested in a 6 x 2 factorial experimental arranged in a split-plot design with three replicates. Growth and yield data were gathered during the study. The results showed that plant growth in terms of height, and yield and yield components, i.e., the number of pods per plant, the length of pods, weight of pods per plant, and pod yield were greater in plots that received 2% SOM from biochar, compared to the same content of SOM by compost, none and 1% SOM by biochar. Adding biochar to maintain 3 and 4 percent SOM did not significantly raise bushita bean yield. Application of fertilizer raised bushita bean pod yield, but the difference was not significant. Therefore, maintaining 2% SOM using biochar was found beneficial. Since this finding is based on a single season experiment, further work is suggested before making firm recommendations.

Keywords: Bushita bean, soil amendments, compost, biochar, inorganic fertilizer.

I. Introduction

The bushita bean is a popular vegetable cultivated in many Asian and African countries. Synthetic fertilizer has been widely used for growing bushita beans in Sri Lanka. The government of Sri Lanka made efforts to promote the use of organic fertilizers (OF). Several types of organic fertilizers were re-introduced among the growers [1]. This includes compost, several types of liquid formulae prepared out of different organic waste, vermicompost, biochar, etc. Since bushita bean belongs to a group of legumes, it possesses the N fixation using atmospheric N_2 to obtain the N requirement. The N fixation process requires the flow of atmospheric N_2 to root nodules. The application of organic matter is known to improve the soil structure thus facilitating the N fixation process [2]. The farmers are encouraged to use compost and biochar using plant parts, mulch, and animal waste.

Organic amendments such as compost, vermicompost, etc. are known to promote soil structure and the retention of nutrients in soil. One of the popular ways of applying organic matter is by biochar which is also known to enhance the retention of carbon and cations in soil [1]. For severely depleted soils with scarce organic matter, and insufficient water and fertilizer supplies, biochar is known to support soil development and crop production [4]. In the absence of adequate evidence testing the role and benefits of biochar would help identify suitable fertility management options for bushita bean cultivations. Therefore, the current study was conducted to compare the effects of biochar with commonly used organic fertilizers on the growth and yield of bushita beans.

II. Materials and Methods

This study was conducted from February to May 2022 in upland in Vitharandeniya of the Hambantota District, Sri Lanka. Bushita bean was the experimental crop. Five soil amendment levels, viz. no amendment, 2% soil organic matter (SOM) with compost, and 1, 2, 3, and 4 percent SOM using Biochar (prepared using rice chaff) were tested with and without inorganic fertilizers in a 6 x 2 factorial arrangement using a split-plot design with three replicates. Soil amendments were randomly assigned to main plots and fertilizer levels to subplots. The experimental site was ploughed, harrowed, and levelled, and seed beds (6m long and 1.5m wide) were prepared. Soil amendments were added to corresponding plots and mix with the topsoil two days before seeding. Subplots assigned to receive inorganic fertilizer, 16 kg N, 25 kg P, and 17.5 kg K per hectare were applied as the basal dressing and 25 kg N and 17.5 kg K as the top dressing one month after seeding as per the Department of Agriculture (DOA) recommendation for bushita crop [4].

The crop was managed as per DOA recommendation [4]. Plant growth in terms of plant height, time to reach phenological stages, and yield data were collected. Analysis of variance was performed for data using SAS software and means were separated using Fisher's protected Least Significance Difference (LSD) test.

III. Results and Discussion

Growth of bushita bean

Plant height was significantly influenced by both soil organic matter and fertilizers (Table 1). The highest plant height was in plots that received 2% SOM with biochar and was significantly different from the plots that received no soil amendments and compost. This indicates that all plots that had biochar (2% SOM) had higher growth than the rest. Significantly lower plant heights were in plots that received no soil amendments and were not significantly different in the quantity of biochar applied. In this performance, compost was inferior to the control as it had the lowest plant height.

The yield of bushita beans

Yield and yield components of bushita beans were significantly influenced by the type and rate of soil amendments and the fertilizer treatments (Table 2). Among the soil amendments, all yield components and the total pod yield (2170 kg/ha) were significantly lowest in compost-added plots. The

highest pod yield was in plots that received 2% Biochar, but plots receiving no soil amendments, and 3 and 4% biochar also had non-significant bushita bean yields. This indicates that biochar offered a higher yield than compost.

Table 1. Effects of organic amendment and fertilizer application on mean plant height at 4 and 8 weeks after seeding (WAS) and dry weight of plants at 4 WAS of bushita bean.

Treatment	Plant height, cm		Plant dry weight 4 WAS, kg/ha
	4 WAS 1/	8 WAS	
Organic amendment			
No amendment added	32.6 b	51.2 ab	1648.1 ab
2% SOM with compost	18.0 c	26.6 c	990.7 c
1% SOM with Biochar	32.9 b	54.2 a	1416.7 b
2% SOM with Biochar	37.3 a	54.2 a	1944.4 a
3% SOM with Biochar	34.7 ab	53.5 ab	1759.3 ab
4% SOM with Biochar	35.8 ab	50.5 b	1750.0 ab
LSD (p<0.05)	4.12	3.14	365.7
Fertilizer application			
No fertilizers applied	29.2b	45.9 b	1478.4 b
Fertilizer applied 2/	34.5a	50.8 a	1691.4 a
LSD (p≤ 0.05)	2.39	1.82	211.2
CV%	10.32	5.16	18.34

Legend: 1/ Values followed by the same letter in the column are not significantly different at p≤0.05.
2/ Subplots receiving inorganic fertilizers as per the Department of Agriculture recommendation (16 kg N, 25 kg P, and 17.5 kg K per hectare as the basal dressing, and 25 kg N and 17.5 kg K as the top dressing one month after seeding) [4].

The use of DOA fertilizer recommendation raised both pod number per plant and pod yield, but the differences were not significant.

Table 2. Effects of organic amendment and fertilizer application on mean pod no per plant, mean pod weight, mean pod length, and pod yield of bushita bean.

Treatment	Number of pods per plant 1/	Weight of pods/plant g	Mean pod length cm	Pod Yield kg/ha
Organic amendment				
No amendment added	11.4 a	6.0	24.8 ab	7915.5 ab
2% SOM with compost	2.7 d	5.0	21.7 d	2169.7 c
1% SOM with Biochar	8.4 c	6.8	25.6 a	6514.6 b
2% SOM with Biochar	11.0 ab	4.7	22.7 cd	8166.6 a
3% SOM with Biochar	9.7 bc	5.1	23.5 bcd	7810.2 ab
4% SOM with Biochar	10.1 ab	5.6	24.2 abc	6907.4 ab
LSD (p<0.05)	1.5	Ns	1.86	1635.1
Fertilizer application				
No fertilizers applied	8.5	5.5 a	23.8	6380.6
Fertilizer applied 2/	9.2	5.6 a	23.7	6780.6
LSD (p≤ 0.05)	Ns	Ns	Ns	Ns
CV%	13.31	15.97	6.2	19.76

Legend: 1/ Values followed by the same letter in the column are not significantly different at p≤0.05.
2/ Subplots receiving inorganic fertilizers as per the Department of Agriculture recommendation (16 kg N, 25 kg P, and 17.5 kg K per hectare as the basal dressing, and 25 kg N and 17.5 kg K as the top dressing one month after seeding) [4].

IV. Conclusion

The results of this study confirmed that the biochar-treated plots were superior to compost-treated plots. Among the biochar soil organic matter levels adjusted with the use of biochar, 2% of the soil organic matter (SOM) provided with biochar gave the highest bushita bean yield. Adding higher biochar levels did not provide additional benefits. Although the use of inorganic fertilizers raised bushita pod yield, the differences were not significant. Therefore, adding biochar to maintain 2% soil organic matter content is recommended based on this study. It is suggested to repeat the study before making firm recommendations.

References

[1]. Islam, M. A., Boyce, A. N., Rahman, M. M., Azirun, M. S., & Ashraf, M. A., Effects of organic fertilizers on the growth and yield of bush bean, winged bean, and yard long bean. Brazilian Archives of Biology and Technology, 59:1–9, 2016.

[2] Wagner, S. C. Biological Nitrogen Fixation. Nature Education Knowledge, 3(10):15, 2011.

[3]. Gamage, D. N. V., Mapa, R. B., Dharmakeerthi, R. S., & Biswas, A. (2016). Effect of rice-husk biochar on selected soil properties in tropical Alfisols. Soil Research, 54(3), 302–310.

[4] Anon (nd.). Yard-long bean (Vigna unguiculata). https://doa.gov.lk/hordi-crop-yard-long-bean/ (Retrieved on 25 August 2022)