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Effect of Integrated Nutrient Management with Biochar on Growth and Yield Parameters of Okra in Western Undulating Agroclimatic Zone of Odisha

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ABSTRACT: The effects of biochar and integrated nutrient management on the development and yield of okra (*Abelmoschus esculentus* (L.) Moench) were investigated in a field experiment conducted in Research plots of college of agriculture, ouat, bhawanipatna during 2021-22. The experiment was laid out in RBD with Seven treatments which were replicated thrice. The treatments were T1 (biochar @ 5 t/ha + 100% RDF), T2 (biochar @ 10 t/ha + 100% RDF), T3 (biochar @ 5 t/ha + 5 t/ha FYM + 100% RDF), T4 (biochar @ 10 t/ha + 5 t/ha FYM + 100% RDF), T5 (biochar @ 5 t/ha + 75% RDF), T6 (biochar @ 10 t/ha + 5 6 75% RDF) and T7 (biochar @ 5 t/ha + 5 t/ha FYM + 75% RDF). The results revealed that biochar has good prospects for use as a soil conditioner for okra in the sandy loam soils of bhawanipatna. The soil application of biochar at the rate of 10 t/ha along with FYM @ 5 t/ha and 100 per cent RDF can be recommended for betterment of the growth and yield of okra in the sandy loam soils of western undulating agroclimatic zone of odisha.

Keywords: Biochar, Growth attributes, Okra, Yield.

INTRODUCTION

Biochar is a carbonaceous material made by pyrolysing biomass. It has a high water-holding capacity, low bulk density, and high porosity. Because of these characteristics, biochar is a great soil conditioner that helps the soil hold onto nutrients and water, boosting output. Because of this, burning crop wastes may exacerbate environmental problems, but they can also be used to make biochar. The amount of agricultural waste generated by India's crops is far more than that of other countries. Farmers are compelled to burn agricultural residues as a quick and easy way to clear the land because there are no suitable methods for doing so. Approximately 43% of India's crop stubbles are burned on fields, according to Singh and Kaskaoutis (2014) research. This leads to a significant level of air pollution.

MATERIALS AND METHODS

The summer of 2021 saw the conduct of an experiment at the research plots of the instructional farm that is connected to the College of Agriculture, OUAT, Bhawanipatna, Odisha. Nine treatments in the RBD-designed field experiment were reproduced three times. Biochar was applied in the following ways: T1 (at 5 t/ha + 100% RDF), T2 (at 10 t/ha + 100% RDF), T3 (at 5 t/ha + 5 t/ha FYM + 100% RDF), T4 (at 10 t/ha + 5 t/ha FYM + 100% RDF), T5 (at 5 t/ha + 75% RDF), T6 (at 10 t/ha + 75% RDF), T7 (at 5 t/ha + 5 t/ha FYM + 75% RDF), T8 (at 10 t/ha + 5 t/ha FYM + 100% RDF), and T9 (20 t/ha FYM + 100% RDF). Clods were broken, stubbles were removed, and the experimental area was cleared. In the experimental region, dolomite at a rate of 1 t/ha was evenly applied and mixed into the soil in addition to tillage. Following the field's arrangement, the soil was treated with half N, full P and full K chemical fertilisers, as well as farm yard waste and soft coconut husk biochar, right before planting. One month after seeding, the remaining N was added to the soil. The okra (var. Arka Anamika) seeds were planted in rows in the main field, 60 cm apart. The final week of January 2022 saw the planting of the crop. Thinning and gap filling were used to maintain a homogeneous population after seeding. Rainfed conditions were used to raise the crop. Ten days and one month after seeding, intercultural, weeding, and earthing up were carried out in addition to nitrogen top dressing. Five plants from each net plot were designated as observational plants, and the outer row in each plot was omitted as the border row. Monthly measurements of each plot's growth characteristics, such as plant height and leaf count, were made until harvest, and an average was calculated. The average height of the plant, measured from the ground (the plant's base) to the terminal bud, was calculated and reported in centimetres. The observational plants' number of fully opened leaves was counted, and the average was computed. In order to avoid breaking any roots, the observing plants were carefully removed with a shovel at harvest, and the dirt was carefully washed away with water. The root depth of the observational plants was ascertained by measuring the length of their tap roots; the mean was then computed and reported in cm. To find the root volume, the roots were immersed in a measuring cylinder that was filled with a predetermined amount of water. The increase in water volume caused by immersing roots is known as the root volume, and it is expressed in cm^3 (Musick *et al.*, 1965). The average number of days between seeding and the first flower opening was determined for the observed plants in each plot. An average was calculated based on the total number of fruits harvested from each plot's observing plants. The observational plants were used to measure the length of the fruits from the tip to the stalk end. The average length was calculated and reported in centimetres. Following each harvest, the weight of the fruits from every observational plant was noted. Following the last harvest, the total weight of fruits from each plot's observed plants from various harvests was calculated and converted to kilogrammes for each plant's fruit output. Following each harvest, the weight of the fruits from each plot—aside from the border plants—was totalled. At the conclusion of the cropping season, the yield in kilogrammes per plot was computed and translated to t/ha. The following formula, proposed by Donald and Hamblin (1976), was used to determine the harvest index.

RESULTS AND DISCUSSION

The plants' heights were measured at 30, 60, and 90 days after sowing (Table 1). Generally speaking, as the crop became older, plant height increased. At 30 DAS, there was no discernible variation in plant height between the treatments. The application of biochar resulted in noticeably higher plants at 60 and 90 DAS. When 100 percent RDF was applied, the plants grew taller than those that received 75 percent RDF. Taller plants were recorded at 60 DAS for treatment T4 (106.65 cm), which was comparable to treatments T3 (104.96 cm) and T2 (102.34 cm).

This could be the result of applying the necessary dosage of nutrients along with the nutrients found in the applied biochar. Okra was observed to grow taller as the amount of biochar was increased. This may be because biochar's adsorption ability improves water and nutrient retention while reducing leaching loss of nutrients. The treatment T4 had taller plants at 90 DAS (142.65 cm), which was comparable to the treatment T3 (134.87 cm).

Southavong *et al.* (2012) showed similar increases in growth metrics in water spinach as a result of applying rice husk biochar. According to Dainy (2015), adding tender coconut husk biochar in addition to NPK as advised had a significant impact on the biometric characteristics of yard long beans. At 30, 60, and 90 days after sowing, the number of leaves on each plant was counted (Table 1). Up until 60 DAS, the number of leaves per plant rose as the crop became older; beyond that, it was seen to decrease until harvest. The treatments had no discernible effect on the number of leaves per plant at 30 or 60 DAS.

At 90 DAS, the amount of leaves per plant was greatly impacted by the biochar application. The treatment T4 had a higher number of leaves per plant (7.21). According to Blackwell *et al.* (2009); Schulz *et al.* (2013), the application of biochar and organic fertiliser on soil nutrient availability resulted in activated plant development, which may have increased the number of leaves per plant in okra. In amaranths, Punnoose (2015) also found that applying biochar in addition to 100% NPK increased the number of leaves per plant. The number of leaves per plant grew as the amount of biochar increased.

Dainy (2015) noted similar outcomes in yard-long beans, showing a much higher number of leaves per plant as a result of the gradual addition of biochar. When comparing treatment T4 to treatment T9, the total number of leaves per plant increased by 18 percent. For the best okra growth and development, Akpa et al. (2019) also suggested using biochar (@ 8 t/ha) and cow dung (@ 12 t/ha) together.

The use of biochar had a major impact on how various treatments affected the okra's root volume and depth (Table 1). It was discovered that there was an inverse link between root depth and root volume. The root volume dropped as the root depth rose. For the plants treated with T9, roots were taken down to a depth of 26.34 cm. Out of all the treatments, treatment T9 had the lowest root volume, measuring 15.35 cm^3. The reduced root volume in T9 plants may be due to the roots going deeper to forage for water and nutrients. Treatment T 4 produced a larger root volume (26.52 cm3). The type of biochar used as a soil conditioner may have kept the nutrients and water at the top soil, which could account for the larger root volume and increased root weight in okra. Amaral *et al.* (2019) observed similar findings of enhanced fresh root weight in chillies as a result of applying 10 t/ha of coconut shell biochar.

T4 produced the largest yield per plant, weighing 554.80 g, which was comparable to that of treatment t3 (545.8 g/plant) (Table 2). Compared to T9, this represented a 40.17 percent rise. The plants that got charcoal and FYM in addition to 100% RDF showed higher fruit yields per plant. The release of nutrients from FYM and chemical fertilisers may have been slowed down by the adsorbing ability of biochar. The weight of the fruit increased as the quantity of biochar doubled. This is consistent with the results of Dainy (2015), who also found that when biochar levels rose from 10 to 30 t/ha when combined with the suggested fertiliser dosage, yard long bean yield and yield-attributing characteristics gradually increased. Similar findings of higher plant yields were found by Hashmi *et al*. (2019) in *Pisum sativum* L. and Punnoose (2015) in amaranthus when charcoal and the recommended dosage of fertilisers were applied. The use of tender coconut husk biochar greatly increased the yield per hectare of okra in terms of fruit yield/ha. The treatment T4 had a higher fruit production per hectare (16.25 t), which was comparable to that of T3 (15.14 t) (Table 2). It was only possible for the control plants (T9) to produce 08.92 t.

Biochar boosts okra output and growth by 7.33 t/ha in Bhawanipatna. T4 yields an overall yield increase of 82.35% compared to T9. The decreased yield per hectare of T9 could be due to the leaching loss of nutrients. 44 mm of rain fell throughout the okra growing season, which would have caused the leaching loss in the Bhawanipatna soils. To boost banana production, Nagula (2017) recommended using biochar at a rate of 10 kg/ha in addition to the right nutrient intake.

Table 1: Effect of different treatments on the growth attributes of okra.

Treatments	Height of the plant (cm)			Number of leaves per plant			Root depth (cm)	Root volume (cm^3)
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	At Harvest	At Harvest
T1	24.50	100.28	119.58	6.25	20.44	6.72	21.15	17.45
T2	25.34	102.34	122.46	6.25	20.66	6.89	21.72	17.85
T3	24.89	104.96	134.87	6.25	20.89	7.11	21.58	21.63
T4	22.34	106.65	142.65	6.25	20.95	7.21	16.85	26.52
T5	25.69	96.42	110.35	6.25	20.33	7.32	17.52	20.32
T6	25.83	96.87	110.59	6.25	20.44	7.46	19.10	16.85
T7	23.43	97.54	111.65	6.19	19.98	6.33	22.72	18.36
T8	21.87	98.69	112.68	6.25	20.44	6.48	24.52	17.55
T9	22.49	92.57	105.98	6.25	20.32	6.11	26.34	15.35
SEm (±)	1.32	2.28	2.94	0.08	0.42	0.32	0.45	2.08
CD (0.05)	NS	6.048	8.484	NS	NS	0.75	1.14	6.36

DAS- Days after sowing; FYM- Farm yard Manure; NS- Not significant; RDF- Recommended dose of Fertilizer

Table 2: Effect of different treatments on the yield attributes and yield of okra.

Treatments	Fruit yield per plant (g)	Fruit yield (t ha^{-1})
T1- biochar @ 5 t/ha + 100% RDF	484.5	11.24
T2- biochar @ 10 t/ha + 100% RDF	491.5	13.21
T3- biochar @ 5 t/ha + 5 t/ha FYM + 100% RDF	545.8	15.14
T4- biochar @ 10 t/ha + 5 t/ha FYM + 100% RDF	554.8	16.25
T5- biochar @ 5 t/ha + 75 % RDF	403.5	12.32
T6- biochar @ 10 t/ha + 75 % RDF	425.6	12.24
T7- biochar @ 5 t/ha + 5 t/ha FYM + 75% RDF	468.9	13.25
T8- biochar @ 10 t/ha + 5 t/ha FYM7+5% RDF	475.6	14.28
T9-20 t/ha FYM + 100% RDF	395.8	08.92
SEm (±)	17.54	0.89
CD (0.05)	51.68	2.06

FYM- Farm yard Manure; NS- Not significant; RDF-Recommended dose of Fertilizer

CONCLUSIONS

Biochar exhibits potential as an okra soil conditioner in the sandy loam soils in Bhawanipatna. To increase okra growth and yield in Bhawanipatna's sandy loam soils, 10 t/ha of biochar combined with 5 t/ha of FYM and a 100% recommended dose of fertiliser may be advised.

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