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Influence of Organic Manures and Inorganic Fertilizers on Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L.) cv. TMOH-2366

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was planned to see the influence of different organic manures and inorganic fertilizers on growth, yield and quality of okra which comprised the combination of organic manures (FYM, neem cake, vermicompost) and inorganic fertilizers (viz., Nitrogen, Phosphorus and Potassium). The experiment was laid out in RBD with 9 treatments with 3 replications. Treatments involved were T0 – 100% RDF + 20 t/ha FYM, T1 – 100% RDF + 10t vermicompost, T2 – 100% RDF + 2t neem cake, T3 –75% RDF + 25% FYM, T4 – 75% RDF + 25% vermicompost, T5 – 50% RDF + 50% neem cake, T6 –50% RDF + 50% FYM, T7 – 50% RDF + 50% vermicompost, T8 – 50% RDF +50% neem cake. The results revealed that T1 (100% through RDF + 10t vermicompost) performed the best in term in days to germination (9.20 DAS), days to emergence (19.87 DAS), days to 50% flowering (49.20 DAS), plant height (75.03 cm), days to first harvest (56 DAS), number of fruits per plant (10), fruit length for marketability (10.71 cm), average fruit weight for 10 capsule (109 g), fruit yield per plant (194.93 g), fruit yield per hectare (116.96 q/ha), total soluble solids (5.80° Brix), ascorbic acid (18.54 mg/100 g), fruit colour (138.33) and B:C ratio (2.81). Therefore, the treatment T1 (100% through RDF + 10t vermicompost) is the best when compared to all other treatments. As the highest

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benefit cost ratio, net return and gross return was observed in T1 (100% RDF + 10t vermicompost) i.e., (2.81), Rs. 226422 and Rs. 350880 which states that it is economically profitable compared to all other treatments.

Keywords: Growth; yield; quality; vermicompost; neem cake; FYM.

1. INTRODUCTION

"Okra (*Abelmoschus esculentus L.*) also known as lady's finger or bhindhi belongs to family Malvaceae having high chromosome number among vegetables (2n= 130). It is native to Africa and grown in tropical and sub-tropical part of the world" [1]. "This crop is suitable for the cultivation as a garden crop as well as on long commercially forms. The composition of okra pods per 100g edible portion (81% of the product as purchased, ends trimmed) is: water 88.6g, energy 144.00 Kj (36 Kcal), protein 2.10 g, carbohydrates 8.20g, fat 0.20g, β-carotene 185.00mg, riboflavin 0.08mg, thiamine 0.04mg, niacin 0.60mg, ascorbic acid 47.00mg" [2]. "The composition of okra leaves per 100 g edible portion is: water 81.50g, energy 235.00 Kj (56.00 Kcl), protein 4.40g, fat 0.60g, carbohydrate 11.30g, fibre 2.10 g, Ca 532.00mg, P 70.00mg, Fe 0.70mg, ascorbic acid 59.00mg, β-carotene 385.00mg, thiamine 0.25mg, riboflavin 2.80mg" [2]. "Carbohydrates are mainly present in the form of mucilage" [3]. That of young fruits consists of long chain molecules with a molecular weight of about 170,000 made up of sugar units and amino acids. The main components are galactose (25%), rhamnose (22%), galacturonic acid (27%) and amino acids (11%). The mucilage is highly soluble in water. The solution in water has an intrinsic viscosity value of about 30%.

"Organic manures can supply practically all the elements of soil fertility that the crops require, though not in adequate amounts and in right proportions. The plant food elements contained in manure are released in available form upon decomposition by soil microorganisms. It improves the quality of green pods. Besides, application of organic manures not only produced the highest and sustainable crop yield, but also improved the soil fertility and productivity of land" [4]. The most important elements present in inorganic fertilizers are nitrogen, phosphorus, and potassium which influence vegetative and reproductive phase of plant growth [5,6].

Use of organic manures and inorganic fertilizers in okra has been reported to show rapid increased in plant height, improved soil physical, chemical and biological properties along with conserving moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce and significantly higher values of fresh pod length and fresh pod weight of okra under normal plant population [7,8].

2. MATERIALS AND METHODS

A field experiment was conducted at Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2022. The sowing of experimental material was done on February 9, 2022.

The experiment material consists of TMOH-2366 variety of okra. The experiment was laid out in randomized block design (RBD) with three replications and nine treatments. Treatments involved were T0 – 100% RDF + 20 t/ha FYM, T1 – 100% RDF + 10t vermicompost, T2 – 100% RDF + 2t neem cake, T3 – 75% RDF + 25% FYM, T4 – 75% RDF + 25% vermicompost, T5 – 50% RDF + 50% neem cake, T6 – 50% RDF + 50% FYM, T7 – 50% RDF + 50% vermicompost, T8 – 50% RDF +50% neem cake. The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were prepared according to layout. The seeds were soaked overnight and sown in the field directly. Light irrigation was given just after sowing of seeds.

Organic manures were applied one week before sowing. The plot size was 1m x 1m with 45cm x 30cm spacing rows and plants. Five plants were randomly selected for recording observations on growth, yield and quality attributing parameters. Full dose of phosphorus, potassium and half dose of nitrogen as per treatments were applied just before sowing. The remaining half dose of nitrogen was applied twenty-five days after sowing.

3. RESULTS AND DISCUSSION

The application of (T1) 100% RDF + 10t Vermicompost was found beneficial in terms of days to germination, days to emergence, days to

50% flowering, plant height (cm), days to first harvest, number of fruits per plant, fruit length for marketability (cm), average fruit weight (g), fruit yield per plant (g), fruit yield per hectare (q/ha), total soluble solids (° Brix), ascorbic acid (mg/100 g) and fruit colour.

Application of nutrients through combinations of organic manures and inorganic fertilizers were proved beneficial in increasing growth, yield as well as quality of okra (Tables 1, 2 and 3).

3.1 Growth Parameters

The statistical data on growth parameters in different treatments was recorded (Table 1). In the experiment the results revealed that the minimum days to germination (cotyledons) was found in T1 (100% RDF + 10t Vermicompost) which is 9.40 DAS whereas maximum days to germination was found in T0 (100% RDF + 20t FYM) which is 11.73 DAS. The minimum days to emergence (true leaf) was found in T1 (100% RDF + 10t Vermicompost) which is 19.87 DAS whereas maximum days to germination was found in T0 (100% RDF + 20t FYM) which is 22.20 DAS. The minimum days to 50% flowering was found in T1 (100% RDF + 10t Vermicompost) which is 49.20 DAS whereas the maximum days to 50% flowering was found in T0 (100% RDF + 20t FYM) which is 52.93 DAS. The maximum plant height was found in T1 (100% RDF + 10t Vermicompost) which was 13.59 cm, 23.65 cm, 56.61 cm, 75.03 cm in 30, 45, 60 DAS and at final harvest whereas the minimum plant height was found in T0 (100% RDF + 20t FYM) which was 10.29 cm, 20.21 cm, 43.29 cm and 60.75 cm in 30, 45, 60 DAS and at final harvest. The minimum days to first harvest was found in T1 (100% RDF + 10t Vermicompost) which is 56 DAS whereas the maximum days to first harvest was found in T0 (100% RDF + 20t FYM) which is 60.33 DAS.

The effect of moisture content and maturity on hardseededness results in the germination days. The use of vermicompost and inorganic fertilizers results in early germination as reported by El Balla, M.M., Saidahmed, A., & Makkawi, M. [9]. The main cause of change in seedling emergence, their survival and vigour of the seedlings [10]. Earliness is assured by days taken for 50 per cent flowering obtained with application of vermicompost + Azospirillum + PSB may be due to solubilization effect of plant nutrient by addition of FYM and vermicompost leading to increased uptake of NPK [11]. Similar findings reported by Subbiah [12] in chilli. Application of organic and inorganic fertilizers T0 (100:50:50 NPK + FYM @ 20t/ha (control)) which resulted in poor performance. It might be due to the increase in the nutrient availability and preponderance of different groups of microorganisms in soil, which created a favourable condition for proper vegetative growth in general and increased plant height in particular. The highest dose of nitrogen might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increasing plant height Meyer and Anderson [13]. Barani and Anburani [14] also supported with similar findings that application of NPK along with vermicompost recorded maximum plant height. Time of harvest of pods, seed moisture content, fertilizer, growth regulators are some of the methods that proposed that have effect on okra seedhardness. It was reported the percentage of hardseedness increased significantly in all cultivars with the increase in the maturity of seed. This may be due to the deposition of hard cuticle or impermeable cell layer of the seed coat during the later stages of seed development [9].

3.2 Yield Parameter

The statistical data on yield parameters in different treatments was recorded (Table 2.) in the experiment the results revealed that the maximum number of fruits per plant was found in T1 (100% RDF + 10t Vermicompost) which is 10.00 whereas the minimum number of fruits per plant was found in T0 (100% RDF + 20t FYM) which is 7.47. The data indicated in Table 2 shows that the maximum fruit length for marketability (cm) was found in T1 (100% RDF + 10t Vermicompost) which is 10.71 cm whereas minimum fruit length for marketability was found in T0 (100% RDF + 20t FYM) which is 8.86 cm. The maximum average weight (g) was found in T1 (100% RDF + 10t Vermicompost) which is 109.00 g whereas minimum average fruit weight was found in T0 (100% RDF + 20t FYM) which is 68.67 g. The maximum fruit yield per plant was found in T1 (100% RDF + 10t Vermicompost) which is 194.93 g whereas minimum fruit yield per plant was found in T0 (100% RDF + 20t FYM) which is 79.63 g. The maximum fruit yield per hectare was found in T1 (100% RDF + 10t Vermicompost) which is 116.96 q/ha whereas minimum fruit yield per hectare was found in T0 (100% RDF + 20t FYM) which is 47.77 q/ha.

Table 1. Influence of organic manures and inorganic fertilizers on growth of okra

Treatment	Days to germina tion (DAS)	Days to emergence (DAS)	Days to 50% flowering (DAS)	Plant height (cm)				Days to first harvest
				30 DAS	45 DAS	60 DAS	Final harvest	
T0 -100% RDF + 20 t/ha FYM	11.73	22.20	52.93	10.29	20.21	43.29	60.75	60.33
T1-100% RDF + 10t vermicompost	9.20	19.87	49.20	13.59	23.65	56.61	75.03	56.00
T2-100% RDF + 2t neem cake	11.00	21.07	50.93	10.93	21.06	51.68	68.99	58.73
T3-100% RDF + 25% FYM	10.33	20.53	50.47	11.76	21.71	53.61	71.85	58.13
T4-75% RDF + 25% vermicompost	10.13	20.33	50.13	12.62	22.58	54.43	72.37	57.53
T5-50% RDF + 50% neem cake	11.20	21.47	52.00	10.90	20.97	49.16	67.92	59.13
T6-50% RDF + 50% FYM	10.80	20.73	50.67	11.31	21.51	51.87	70.48	58.33
T7-50% RDF + 50% vermicompost	9.40	20.07	49.67	13.01	23.03	55.25	73.24	57.00
T8-50% RDF +50% neem cake	11.40	21.73	52.00	10.45	20.52	47.22	67.27	59.60
S.Ed (±)	0.29	0.19	0.29	0.20	0.23	1.37	1.37	0.35
CD at 5%	0.61	0.40	0.62	0.42	0.48	2.90	2.91	0.75

Table 2. Influence of organic manures and inorganic fertilizers on yield of okra

Treatment No.	Number of fruits per plant	Fruit length for marketability (cm)	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (q/ha)
T0 -100% RDF + 20 t/ha FYM	7.47	8.86	68.67	79.63	47.77
T1-100% RDF + 10t vermicompost	10.00	10.71	109.00	194.93	116.96
T2-75% RDF + 2t neem cake	8.40	9.56	89.00	117.90	70.74
T3-100% RDF + 25% FYM	9.00	10.21	94.17	142.40	85.44
T4-75% RDF + 25% vermicompost	9.27	10.38	98.33	152.70	91.62
T5-50% RDF + 50% neem cake	8.07	9.19	85.00	106.27	63.76
T6-50% RDF + 50% FYM	8.67	9.85	91.50	125.90	75.54
T7-50% RDF + 50% vermicompost	9.73	10.49	103.50	175.30	105.18
T8-50% RDF +50% neem cake	7.67	9.03	72.83	95.17	56.95
S.Ed (±)	0.13	0.12	5.55	4.44	2.66
C.D. at 5%	0.28	0.26	11.76	9.42	5.64

Table 3. Influence of organic manures and inorganic fertilizers on quality of okra

Treatment No.	Total soluble acid (° Brix)	Ascorbic acid (mg/100 g)	Fruit colour	Gross Return (Rs./ha)	Cost of cultivation (Rs./ha)	Net Return (Rs./ha)	B:C ratio
T0-100% RDF + 20 t/ha FYM	2.30	14.55	132.06	143280	121683	21597	1.17
T1-100% RDF + 10t vermicompost	5.80	18.54	138.33	350880	124458	226422	2.81
T2-75% RDF + 2t neem cake	3.67	15.95	133.8	212220	121683	89149	1.72
T3-100% RDF + 25% FYM	4.53	17.18	134.46	256320	108300	148020	2.36
T4-75% RDF + 25% vermicompost	4.95	17.46	135.13	274860	108995	165865	2.52
T5-50% RDF + 50% neem cake	3.20	15.74	133.73	191280	108647	82633	1.76
T6-50% RDF + 50% FYM	4.03	16.80	134	226620	111562	115058	2.03

Treatment No.	Total soluble acid (° Brix)	Ascorbic acid (mg/100 g)	Fruit colour	Gross Return (Rs./ha)	Cost of cultivation (Rs./ha)	Net Return (Rs./ha)	B:C ratio
T7-50% RDF + 50% vermicompost	5.51	17.96	136.4	315540	112952	202588	2.79
T8-50% RDF +50% neem cake	2.57	14.89	132.66	170850	112256	58594	1.52
S.Ed (±)	0.14	0.26	0.76				
C.D at 5%	0.30	0.56	1.61				

Fig. 1. Characteristics of different treatments of okra cv. TMOH-2366

Number of fruits per plant might be due to the better availability and uptake of nutrients by plants for a longer duration of crop growth. Similar findings of significantly higher number of fruits per plant by integrated application of fertilizers have been reported by Prabhu et al. [15] and Mal et al. [16] in okra. Fruit length for marketability might be attributed to the increased availability of NPK and water at the critical stages of the crop growth resulting early establishment, vigorous growth and development of plants leading to longer. Higher value in pod length of okra observed due to integrated application of fertilizers by Naidu et al. (2002). Similar results were also obtained in okra by Gayathri and Reddy [17] and Mal et al. [16]. The highest fruit weight with combined application of inorganic and organic fertilizers, i.e., with 50 per cent fertilizers + 50 per cent phosphobacteria in okra-pea-tomato rotation which was recorded by Rabindra Kumar and Srivastava [18]. The increase in fresh fruits weight of okra due to vermicompost and poultry manure application could be attributed to easy solubilization effect of released plant nutrient leading to improve nutrient status and water holding capacity of the soil. The results obtained were in agreement with the findings of Premsekhar and Rajashree [19] in okra in which they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. Highest fruit yield was recorded with application of organic and inorganic fertilizers. Application of pure organic or pure inorganic resulted in low yield. The manurial combination showed a lot of difference in the fruit yield of the plant. These results are in support with findings of Prabu et al. [15]. Similar results are also reported by Sharma et al. [20] that application of 5t/ha vermicompost recorded significantly higher values of yield attributes, fruit yields (69.2 q/ha) and protein content 18% as well as B:C ratio (2:11) with net returns of rupees 35614 ha-1 in okra crop.

3.3 Quality Parameter

The statistical data on quality parameters in different treatments was recorded (Table 3) in the experiment results revealed that the maximum total soluble solids was found in T1 (100% RDF + 10t Vermicompost) which is 5.80° Brix whereas minimum total soluble solids was found in T0 (100% RDF + 20t FYM) which is 2.30° Brix. The maximum ascorbic acid was found in T1 (100% RDF + 10t Vermicompost) which is 18.54 mg whereas minimum ascorbic acid was found in T0 (100% RDF + 20t FYM) which is 14.55 mg. The maximum fruit colour was found in T1 (100% RDF + 10t Vermicompost) which is 138.33 whereas the minimum fruit colour was found in T0 (100% RDF + 20t FYM) which is 132.06.

The progressive increase in the parameters may be due to the fact that the vermicompost being a major contributor of micronutrients to the soil and plant growth promoters like gibberellins, cytokinin and auxins, might have improved the physical (like bulk density, porosity, water holding capacity, soil structure), chemical (nutrient status, soil pH) and biological properties (Azotobacter and PSB, fungi, actinomycetes, earthworms activities) of soil by enriching the certain metabolites and vitamins that had provided favourable environment for better growth and development of plant which ultimately increased the synthesis and accumulation into the fruit. The findings get full support with the findings of Yadav et al. (2016) and Singh et al. [21]. “With regards to quality parameters of okra, the results revealed that increasing levels of nitrogen and potassium increased the ascorbic acid and the value range from 13.68 to 18.87 mg 100 g-1” (B. Naveen Kumar, G. Padmaja and P. Chandrasekhar Rao, 2017). “There is a considerable diversity in *A. esculentus* fruit colours (e.g. light green, green, dark green, pink, and mauve). Studies have shown that anthocyanins can protect against radiation, while also delaying aging and decreasing blood lipid levels” [22].

3.4 Economics

In terms of economics, maximum benefit cost ratio 2.81 was observed in treatment T1 (100% RDF + 10t vermicompost) whereas minimum benefit cost ratio was observed in T0 (100% RDF + 20t FYM) which is 1.17.

4. CONCLUSION

Based on the present experimental findings, it maybe concluded that the treatment T1 (100% RDF + 10t vermicompost) was found superior in days to germination, days to emergence, days to 50% flowering, plant height (cm), days to first harvest, number of fruits per plant, fruit length for marketability (cm), average fruit weight (g), fruit yield per plant (g), fruit yield per hectare (q/ha), total soluble solids (° Brix), ascorbic acid (mg/100g) and fruit colour of okra. Regarding economics of various treatments, maximum gross return (Rs. 350880) and net return (Rs. 226422) along with the cost benefit ratio (2.81) was also obtained in T1 (100% RDF + 10t vermicompost).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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