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Effect of nutrient management on growth attributes of organic okra (*Abelmoschus esculentus* (L) Moench) in Coimbatore region

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Abstract
This study aimed to find out best organic manure or manure combination for obtaining the maximum growth from okra, and to standardize the total NPK requirement through organic manures. The study was conducted in the South farm of the School of Agricultural Sciences, Karunya institute of Technology and Sciences, Coimbatore during the *Rabi* season of 2022. The experimental design consisted of ten treatments, including a control T10 in a Randomised Complete Block Design (RCBD) that was replicated thrice. The combination of FYM, Vermicompost, Composted poultry manure and groundnut cake has been practiced in T5 to T9, and the other five treatments were based on different organic practices. The result showed that T_8 (90.26 cm) had a significant positive effect on plant height, while T7 (27.17) recorded the maximum number of leaves plant^{-1} and T10 (33.0) for the minimum number of days to first flowering. Maximum dry matter production was reported in T10 (25.50 kg h^{-1}). While maximum leaf area index was noticed in T8 (3.71) during the rabi season of 2022.

Keywords: Okra, organic nutrient management, growth attributes, poultry manure, vermicompost, Arka Anamika

1. Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the major vegetable crops of India. It is also called lady's finger in English, quimgombo in Spanish, gumbo in French and bhindi in Hindi. It is grown from tropical to sub-tropical and warmer part of temperate zone of the country. Vegetable farming is one of the profitable farming as compared to other crops. okra farming is one of the profit-oriented farming where a farmer or an agripreneur can earn income with minimum amount of investment. In south Indian conditions, the crops can be grown throughout the year since frost and severe winters are absent. The problem faced in okra farming is the large-scale use of chemical fertilizers and heavy use of pesticides with the minimum use of organic manures. This system of cultivation pollutes the environment through nitrates in water, nitrous oxide in air which depletes the ozone layer and pesticides in the crop harvested. However, a safer farming of okra is required. Commonly used organic manures include the excreta of animals and birds, green manures, compost *etc*., and application of these manures is a viable option for waste management also. Organic manures play an important role in increasing organic carbon content and all essential plant nutrients in the soil and improving the cations exchange capacity of soil. Availability of quality organic manures is the major constraint especially in organic farming. The prolonged and over usage of chemicals has, however, resulted in human and soil health hazards along with environmental pollution (Benchasri *et al*., 2012) [1]. Farmer are therefore, being encouraged to convert their existing farms into organic farm. Environmental, social and economic sustainability are the basics of organic farming. The key characteristics include protecting the long-term fertility of soils by maintaining organic matter levels, fostering soil biological activity, careful mechanical intervention, nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, effective recycling of organic materials including crop residues and livestock wastes and weed, diseases and pest control relying primarily on crop rotations, natural predators, diversity, organic manuring and resistant varieties (PAU *et al*., 2019) [5]. A great emphasis is placed to maintain the soil fertility by returning all the wastes to it through different kinds of organic manure to minimize the gap between NPK addition and removal from the soil.

2. Materials and Methods

2.1 Study Area Location

The experiment was conducted during *Rabi* (Oct-Jan) season of 2022-23 in the south farm of Karunya Institute of Technology and Sciences, Coimbatore. The experimental site is geographically located in the western agro-climatic zone of Tamil Nadu at 10^0 56'N latitude and 76^0 44'E longitude at an elevation of 474 m above mean sea level. 3.1.2. The mean annual rainfall of Coimbatore is 504.29 mm distributed over 49 rainy days. The mean annual maximum and minimum temperature are 38 °C and 19.41 °C respectively. The mean relative humidity is 86 percent and the mean evaporation is 6.2 mm per day. The mean bright sunshine hours per day is 7.1 hours. The weather conditions prevailed during the cropping period from October 2022 to January 2023. During the cropping period, the maximum and minimum temperatures ranged from 27.90 °C to 14.50 °C respectively. The total rainfall received during the cropping period in 2022-2023 was 492.23 mm. The mean RH ranged from 76% to 90%.

2.2 Experimental details

Field experiment were laid out in Randomized block design and the treatments were replicated thrice. The treatments followed for the field experiments conducted during the course of the study were the T_1 - NPK @ 40-50-30 kg ha^{-1}through fertilizer alone, T_2 - FYM @ 25 t ha^{-1} alone, T_3 - Vermicompost equivalent to N in 25 t FYM, T_4 - Composted poultry manure equivalent to N in 25 t FYM, T_5 - FYM+ Vermicompost + Composted poultry manure equivalent to supply $1/3^{rd}$ N each available in 25 t of FYM, T_6 - 25 t FYM + groundnut cake equivalent to 40 kg fertilizer N applied as fermented solution at 10 and 30 DAS equally, T_7 - Vermicompost equivalent to N in 25 t FYM + groundnut cake equivalent to 40 kg fertilizer N applied as fermented solution at 10 and 30 DAS, T_8 - Composted poultry manure equivalent to N in 25 t FYM + groundnut cake equivalent to 40 kg fertilizer N applied as fermented solution at 10 and 30 DAS, T_9 - FYM + Vermicompost + Composted poultry manure equivalent to supply $^1/_3$ rd N each available in 25 t FYM + groundnut cake equivalent to 40 kg fertilizer N applied as fermented solution at 10 and 30 DAS, T_{10} - Package of Practices: 25 t FYM + NPK 40-50-30 kg/ha through fertilizers. P and K will be adjusted through rock phosphate and wood ash if needed. Five plants were selected at random from the net plot area of each treatment and tagged. The following parameters were recorded in those tagged plants at different days. Plant height was measured at 60 and 90 DAS and at harvest stage in the five tagged plants from the ground level to tip of the plant and the mean value was expressed in (cm). The number of leaves was manually counted in the five tagged plants at 60, 90, and harvest stages and the means were recorded. The plants were observed daily after 35 days of sowing to see the appearance of first flower and total number of days from sowing time to the date when first flower appear were counted. Five plants selected at random at all stages from each plot outside the net plot but within the border rows were cut close to the ground level and the samples were collected. These samples were shade dried and then oven dried at 80 °C for 72 hours. The dry matter production was computed per unit area and expressed in kg ha^{-1} at 60, 90 DAS and at harvest. Leaf area at 60 and 90 DAS and at harvest were recorded from the five tagged plants. The leaf area was measured with the help of leaf area meter. The average leaf area (cm^2) of one plant was calculated and recorded. The total number of leaves in each plant, the leaf length, and the maximum width of a fully expanded leaf (third leaf from the top) were measured on 60, 90 DAS and at the harvest stage from the five tagged plants in each treatment plot. The Williams formula was used to calculate LAI (1946).

LAI = Leaf area $plant^{-1}$ / ground area occupied plant. (1)

2.3 Statistical Analysis

The data collected on various characters studied during the experiment were subjected to statistical analysis in randomized block design following the method of Gomez and Gomez (1984) [2]. Critical difference was worked out the at five percent probability level wherever the treatments were significant. The treatments differences that were non-significant at 5 per cent denoted as NS.

3. Results and Discussion

3.1 Effect of nutrient management practices on growth parameter of Okra

3.1.1 Plant height (cm)

The data on plant height at different stages of growth (60 DAS, 90 DAS, and at final harvest) are presented in the Table 1. At 60 DAS there was no significant difference in plant height. However, the maximum height of plant was observed in T_{10} (21.83 cm) followed by T_7 and T_8. The Lowest plant height was observed in T_2 (17.04 cm). At 90 DAS the plant height was significantly influenced by the organic manure, maximum plant height was observed in T_7 (55.11 cm) and it was at par with T_1, T_3, T_5, T_8 and $T_{10,}$ and was significantly superior over T_2, T_4, T_6 and T_9. The lowest plant height was observed in T_2 (39.09 cm) and it was at par with T_4, T_6, and T_9. At final harvest also plant height was significantly influenced by the treatments. The maximum plant height was recorded in T_8 (90.26 cm) and it was at par with T_1, T_3, T_7, T_8 and T_{10} and was significantly superior over T_2, T_4, T_5, T_6 and T_9. The lowest plant height was observed in T_2 (65.04 cm) and it was at par with T_4, T_5, T_6 and T_9.

The result indicated that T_8 had a significant positive effect on plant height which is even superior than the treatment $T_{7.}$ These findings were consistent with the previous research that demonstrate the benefits of organic manure that have the ability to supply nutrients and also improve soil fertility by activating soil microbial load and nutrient recycling which led to increased up take of NPK, reduces the nutrient losses, improving the fertilizer use efficiency and sustains cropping system. Application of organic manure which might have accelerated vigorous growth, increased yield of okra plant. Similar findings were reported by (Shelar *et al.*, 2011) [7].

Table 1: Effect of nutrient management practices on plant height (cm) of okra

Treatments	60 DAS	90 DAS	Harvest
T_1	20.44	48.69	77.92
T_2	17.04	39.09	65.04
T_3	19.78	50.47	80.16
T_4	18.48	41.24	68.78
T_5	20.08	47.26	75.26
T_6	18.86	43.33	70.40
T_7	21.33	55.11	86.00
T_8	21.33	52.33	90.26
T_9	19.34	45.11	73.22
T_{10}	21.83	54.09	86.00
S.E. (m±)	1.134	2.734	4.403
CD (p=0.05)	N S	7.865	12.726

3.1.2 Number of leaves plant^{-1}

The data on number of leaves plant^{-1} at different stages of growth (60, 90 DAS and at final harvest) are presented in the Table 2. At 60 DAS, at all stages of growth, number of leaves per plant was significantly influenced by the treatment. It was observed that maximum number of leaves plant^{-1} (8.80) was higher in $T_{7,}$ and it was at par with T_8 and T_{10} were significantly superior over T_1, T_2, T_3, T_4, T_5, T_6 and T_9. The lowest number of leaves plant^{-1} (6.67) was found in T6 and was at par with T_1, T_2, T_3, T_4, T_5 and T_9. At 90 DAS, maximum number of leaves plant^{-1} (12.53) was observed in T_7 and was at par with T_1, T_3, T_8 and T_{10} and was significantly superior over T_2, T_4, T_5, T_6 and T_9. The lowest number of leaves plant^{-1} (8.50) was found in T_2 and it was at par with T_4, T_5, T_6 and T_9. At final harvest, the maximum number of leaves plant^{-1} (27.17) was observed in T_7 and was at par with T_1, T_3, T_8 and T_{10} was significantly superior over T_2, T_4, T_5, T_6 and T_9. The lowest number of leaves plant^{-1} (14.00) was found in T_4 and was on par with T_2, T_5, T_6 and T_9.

The result shows that T_7 recorded the maximum number of leaves plant^{-1} when compared with all the other treatments, and T_2 shows the lowest number of leaves plant^{-1}. This demonstrates that organic manures enhanced the morpho-physiological parameters such as plant height, number of branches per plant, number of leaves per plant, number of flowers per plant, and days to 50 percent flowering significantly when compared to control. (Gaikwad *et al.*, 2021) [8] reported that plant growth regulators.

Table 2: Effect of nutrient management practices on No. of Leaves Plant^{-1} of okra

Treatments	60 DAS	90 DAS	Harvest
T_1	7.00	11.20	21.30
T_2	6.93	8.50	12.50
T_3	7.20	11.80	22.50
T_4	7.40	9.00	14.00
T_5	7.13	10.80	19.00
T_6	6.67	9.50	16.00
T_7	8.80	12.53	27.17
T_8	8.20	12.00	24.00
T_9	7.27	10.30	17.47
T_{10}	8.40	12.40	26.00
S.E. (m±)	0.410	0.582	1.080
CD (p=0.05)	1.228	1.742	3.234

3.1.3 Days to first flowering

The data on days to first flowering on different treatment are presented in the Table 3. The days to first flowering was significantly influenced by the treatments, lateness for flowering (42.9) was observed in T_2 and T_9 and was at par with T_1, T_4, T_5 and T_6. These treatments were significantly superior over T_3, T_7, T_8 and T_{10}. The earliest flowering (33.0) was found in T_{10} and was at par with T_3, T_7 and T_8.

The result shows that minimum number of days to first flowering was recorded in T_{10} these findings were consistent with the previous research that demonstrates FYM, and VC alone or in combination improved yield and yield-attributing characteristics. Application of FYM in combination with VC taken minimum number of days to first flowering. These results are accordance with Ghuge *et al.*, 2015 [9] and Lal and Kumar (2016) [10].

Table 3: Effect of nutrient management practices on Days to first flowering of okra

Treatments	Days to first flowering
T_1	37.4
T_2	42.9
T_3	39.4
T_4	38.3
T_5	40.3
T_6	37.2
T_7	35.2
T_8	34.2
T_9	42.9
T_{10}	33.0
S.E. (m±)	2.127
CD (p=0.05)	6.369

3.1.4 Dry matter production (kg ha^{-1})

The data on dry matter production at different stages of growth (60 DAS, 90 DAS and at final harvest) are presented in the table 4. At 60 DAS, at all the stages of observation plant dry matter production was significantly influenced by the treatment, maximum dry matter production (5.37 kg ha^{-1}) was observed in T_5 and was at par with T_3, T_6 and T_9 these treatments were significantly superior over T_1, T_2, T_4, T_7, T_8 and T_{10}. The lowest dry matter production (4.15 kg ha^{-1}) was found in T_7 and was at par with T_1, T_2, T_4, T_8 and T_{10}. At 90 DAS, at all the stages of observation plant dry matter production was significantly influenced by the treatment, maximum dry matter production (23.60 kg ha^{-1}) was observed in T_9 and was at par with T_3, T_5, T_8 and T_{10} these treatments were significantly superior over T_1, T_2, T_4, T_6, and T_7. The lowest dry matter production (10.00 kg ha^{-1}) was found in T_1 and was at par with T_2, T_4, T_6 and T_7. At final harvest, at all the stages of observation plant dry matter production was significantly influenced by the treatments, maximum dry matter production (25.50 kg ha^{-1}) was observed in T_{10} and was at par with T_3, T_7 and T_9 these treatments were significantly superior over T_1, T_2, T_4, T_5, T_6 and T_8. The lowest dry matter production (12.80 kg ha^{-1}) was found in T_4 and was at par with T_1, T_2, T_5, T_6 and T_8.

The result shown that maximum dry matter production was reported in T_{10} which is superior when compared to other treatments. T_7 recorded the lowest dry matter production which received a combination of VC and groundnut cake as fermented solution. This demonstrates that combination of FYM and NPK. Where P and K adjusted through rock phosphate and wood ash increases the dry matter production in plants. These results agree with those of Muhammad *et al*, (2018) [3], Verma *et al*, (2019) [6].

Table 4: Effect of nutrient management practices on dry matter production (kg ha^{-1}) of okra

Treatments	60 DAS	90 DAS	Harvest
T_1	4.55	10.00	19.53
T_2	4.42	11.10	15.20
T_3	5.13	19.90	21.63
T_4	4.72	10.06	12.80
T_5	5.37	18.53	20.50
T_6	5.21	11.10	19.30
T_7	4.15	13.50	25.10
T_8	4.48	16.30	18.60
T_9	5.12	23.60	24.30
T_{10}	4.27	15.50	25.50
S.E. (m±)	0.255	0.819	1.122
CD (p=0.05)	0.765	2.452	3.359

3.1.5 Leaf area index

The data on leaf area index at different stages of growth (60 DAS, 90 DAS and at final harvest) are presented in the Table 5. At 60 DAS, at all stages of observation the leaf area index was significantly influenced by the treatments, higher leaf area index (0.72) was observed in T_2 and was at par with T_3, T_4, T_5, T_6, T_7, T_8 and T_9 these treatments were significantly superior over T_1 and T_{10}. The lowest leaf area index (0.52) was found in T_1 and was at par with T_{10}. At 90 DAS, at all stages of observation the leaf area index was significantly influenced by the treatments, maximum leaf area index (3.71) was observed in T_8 and was at par with T_3, T_4, T_6, T_7, T_9 and T_{10} these treatments were significantly superior over T_1, T_2 and T_5. The lowest leaf area index (1.10) was found in T_1 and was at par with T_2 and T_5. At harvest all stages of observation the leaf area index was significantly influenced by the treatments, maximum leaf area index (0.83) was observed in T_2 and was at par with T_3, T_4, T_5, T_6, T_7 and T_9 these treatments were significantly superior over T_1, T_8 and T_{10}. The lowest leaf area index (0.63) was found in T_1 and was at par with T_8 and T_{10}.

The result shows that higher leaf area index was recorded in T_8 which is superior to all the other treatments and the lowest leaf area index is observed in T_1 these findings were consistent with the previous research that demonstrates the combination of composted poultry manure, FYM and groundnut cake applied as a fermented solution increases the leaf area index. Similarly, the result was also observed by (O. A. Agba *et al*, 2011) [4].

Table 5: Effect of nutrient management practices on leaf area index of okra

Treatments	60 DAS	90 DAS	Harvest
T_1	0.52	1.10	0.63
T_2	0.72	1.77	0.83
T_3	0.70	3.68	0.81
T_4	0.69	3.29	0.80
T_5	0.68	2.01	0.79
T_6	0.66	2.84	0.77
T_7	0.65	3.61	0.76
T_8	0.63	3.71	0.74
T_9	0.65	3.52	0.76
T_{10}	0.59	2.92	0.70
S.E. (m±)	0.035	0.162	0.031
CD (p=0.05)	0.104	0.486	0.092

4. Conclusion

Through this study we can conclude that application of organic manures helped to enhance the crop growth and development, and also improved the soil structure and texture and nutrient status of soil. In this study all the treatments were performed well for the above-mentioned parameters. Especially when we apply (T8) Composted poultry manure equivalent to N in 25 t FYM + groundnut cake equivalent to 40 kg fertilizer N applied as fermented solution at 10 and 30 DAS was found to be effective in enhancing the crop growth, quality of pod and yield, when compared to other treatments. Overall, we can conclude that using of organic manures over chemical fertilizers will be always advantageous for crop and to the environment also.

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