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**Vaishali Negi**
M.Sc. Research Scholar, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

**Devi Singh**
Associate Professor, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

**C John Wesley**
Associate Professor, Department of Centre for Geospatial Technologies, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

**Corresponding Author:**
**Vaishali Negi**
M.Sc. Research Scholar, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

# Influence of integrated nutrient management on growth, yield and quality parameters of okra under Prayagraj Agroclimatic conditions

**Vaishali Negi, Devi Singh and C John Wesley**

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**Abstract**
A field experiment was carried out to investigate the "Effect of Integrated Nutrient Management on Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L. Moench). During February to July 2023 at Vegetable Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.). Different combination of organic and inorganic fertilizers with different cultivars of okra such as TMOH 2366, Okra 2361, Okra TMOH 375, okra check variety Samrat was incorporated to assess the vegetative growth, yield and Quality characteristics of Okra. The experiment was laid out in factorial randomized block design (FRBD) with sixteen treatment combinations viz $T_1$ (control + TMOH 2366), $T_2$ (FYM-15 t/ha + TMOH 2366), $T_3$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 2366), $T_4$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + TMOH 2366), $T_5$ (control + Okra 2361), $T_6$ (FYM-15 t/ha + Okra 2361), $T_7$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra 2361), $T_8$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra 2361), $T_9$ (control + Okra TMOH 375), $T_{10}$ (FYM-15 t/ha + Okra TMOH 375), $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra TMOH 375), $T_{12}$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra TMOH 375), $T_{13}$ (control + okra check variety Samrat), $T_{14}$ (FYM-15 t/ha + okra check variety Samrat), $T_{15}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + okra check variety Samrat), $T_{16}$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + okra check variety Samrat) and three replications. The data analysis revealed that treatment $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 375) showed superior performance as compared to other treatments in numerous growth parameters, such as the minimum number of days to germination (9.13), maximum germination percentage (82.70%), plant height (92.46 cm), seedling root length (10.47 cm), shoot length (21.57 cm) and seedling length (32.03 cm). Besides, the $T_{11}$ treatment also showed best results in terms of pod width (4.45 cm), pod length (14.30 cm), yield per plant (143.56 g), and yield per hectare (26.58 t) as yield characteristics. Furthermore, $T_{11}$ exhibited higher levels of TSS ($3.66^0$Brix) and vitamin C content (18.69 mg) as quality attributes. On the other hand, treatment $T_1$ (control + TMOH 2366) showed the lowest response in terms of growth, yield, and quality.

**Keywords:** Okra, integrated nutrient management, growth, yield, quality

## Introduction
Okra, belonging to the Malvaceae family, is a highly significant vegetable crop that thrives throughout the wet and humid seasons. It is native to tropical and subtropical areas of Africa and is widely known as a lady's finger or Bhindi. India contributes the world in okra production, producing 6371 thousand metric tons in an area of 534 thousand hectares (NHB, 2019-20). According to Chittora and Singh (2016) [7], Uttar Pradesh, Andhra Pradesh, West Bengal, Bihar, Maharashtra, and Karnataka are the leading states in India for producing okra. The okra plant is a vertical, annual plant with greenish leaves and a red stem. The leaves are 10-20 cm in both length and breadth and have a palmately lobed structure with 5-7 lobes. The flowers have a width that varies between 4 and 8 cm. The flowers are composed of five petals that range in color from white to yellow. Usually, every petal possesses red or purple spots on its lower surface. The fruit is an elongated capsule with a maximum length of 18 cm, containing several seeds.
Okra is nutritious, although seedling emergence and vigour may be low. Young, immature okra pods are significant as fresh fruits, and they can be eaten in a variety of ways. Fruits can be cooked, boiled, or fried (Akintoye *et al.*, 2011) [8]. Water 88.6 g, energy 144.00 kJ (36 kcal), protein 2.10 g, carbohydrate 8.20 g, fat 0.20 g, fibre 1.70 g, Ca 84.00 mg, Iron1.20 mg,

carotene 185.00 g, riboflavin 0.08 mg, thiamine 0.04 mg, niacin 0.60 mg, ascorbic acid 47.00 mg (Gemede *et al*., 2016). Okra mucilage can be employed in medical and industrial purposes. It is utilised as a plasma replacement or blood volume expander in medicine. Okra mucilage is commonly used in industry to glaze certain papers and in confectionery (Benchasri, 2012) [10].

The world's population is growing, which means that the need for food is also growing. In order to satisfy this demand, the cultivation of food is heavily dependent on chemical fertilizers, pesticides, herbicides, and other similar substances. Both the ecosystem and the productivity of the land have suffered as a consequence of the increased production that has resulted from the use of chemical farming. Okra is a heavy feeder of both macro and micronutrients for optimal economic yields which play a key role in okra production, both in terms of quality and quantity. According to Sachan *et al.,* (2017) [1], the use of inorganic fertilizers without discrimination has led to a decrease in the absorption of nutrients, a decrease in the quality of vegetables, and a decline in the health of the soil. It is useful for improving soil, chemical, and biological health, reducing nutrient loss, increasing nutrient uptake and absorption, leading to continuous production without harmful residues, and improving vegetable quality.

Organic manure is a reliable source of both macro and micronutrients, and it is also useful for improving the quality of vegetables. It has been noted that relying solely on natural or synthetic fertilizers is insufficient for preserving soil fertility and ensuring high crop yields. Nevertheless, the combination of the components seems to have a greater yield, better quality, and improved nutrient absorption compared to the individual components. An integrated nutrient management system (INMS) is crucial for maintaining soil health and ensuring sustainable crop production. It effectively utilizes all available fertilizer sources to achieve these goals. The utilization of chemical fertilizers, organic fertilizers, and biofertilizers can effectively preserve soil health and fertility (Gurjar *et al*., 2022) [11]. The study conducted by Kumar *et al.,* (2022) [12] demonstrates that vegetable crops have positive responses to the provision of nutrients using both organic and chemical fertilizers. Thus, in this study, we aimed on assessing the role of recommend dose of fertilizers in sole and integrated management using chemical and organic sources; aiming for obtaining the influence of different treatments on growth, yield and quality of different cultivars of okra.

## Materials and Methods

The experiment was carried out under Prayagraj Agroclimatic condition at the Vegetable Research Farm, Department of Horticulture, Prayagraj School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) during February to July 2023. The experiment was laid out in factorial randomized block design (FRBD) with sixteen treatments and three replications. Different treatments involved in experiment were $T_1$ (control + TMOH 2366), $T_2$ (FYM-15 t/ha + TMOH 2366), $T_3$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 2366), $T_4$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + TMOH 2366), $T_5$ (control + Okra 2361), $T_6$ (FYM-15 t/ha + Okra 2361), $T_7$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra 2361), $T_8$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra 2361), $T_9$ (control + Okra TMOH 375), $T_{10}$ (FYM-15 t/ha + Okra TMOH 375), $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra TMOH 375), $T_{12}$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra TMOH 375), $T_{13}$ (control + okra check variety Samrat), $T_{14}$ (FYM-15 t/ha + okra check variety Samrat), $T_{15}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + okra check variety Samrat), $T_{16}$ (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + okra check variety Samrat). The plant-to-plant distance 30 cm and row to row distances includes 45 × 30 cm with a plot size of 0.90 × 1.8 m. One tractor draws cultivator cross cultivation, two harrowing, and one planking were done before seeding to obtain good soil tilth. Properly maintained channels for irrigation and bunds. Seeds were planted directly in the field. Sowing was followed by light irrigation. Organic manures were administered one week before planting for optimal decomposition, and full phosphorus, potassium, and half nitrogen doses were applied before sowing. The second half of nitrogen was sprayed 30 days after seeding. All cultural practices were followed during crop growth, and growth characters like minimum number of days to germination, germination percentage, plant height, seedling root length, shoot length, seedling length, yield parameters like width of pod, length of pod, yield per plant, total yield, and quality parameters like TSS and vitamin C were observed. Statistical analysis was used to draw inferences from these factors.

## Results and Discussions

The physiological growth attributes, such as the minimum number of days required for germination, germination %, plant height, seedling root length, shoot length, and seedling length, were substantially affected by various treatments, as indicated in Table 1 and Table 2. The use of a combination of organic manure and synthetic fertilisers had a beneficial impact on the overall physiological characteristics, resulting in increased growth of the Okra crop. The maximum vegetative growth in terms of the minimum number of days to germination (9.13), maximum germination percentage (82.70%), plant height (92.46 cm), seedling root length (10.47 cm), shoot length (21.57 cm) and seedling length (32.03 cm) were recorded in the treatment combination $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 375). The minimum values for all above growth attributes were recorded in $T_1$ (control + TMOH 2366). These results are closely confined with the findings of Sachan *et al.,* (2017) [1]; Kota *et al.,* (2022) [2] and Singh *et al.,* (2020) [3]. The yield parameters like width of pod, length of pod, yield per plant, total yield was influenced significantly as presented in Table no. 2 and Table no. 3, by the combination of organic and inorganic fertilizers in different treatments which were recorded after harvesting of pods. The maximum pod width (4.45 cm), pod length (14.30 cm), yield per plant (143.56 g), and yield per hectare (26.58 t) were recorded with the treatment $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 375). Similar results were reported by Prasad and Naik, (2013) [5]; Saurabh and Khandwe, (2021) [6]. The nutritive value of the pods has been determined based on the combined amount of total soluble solids and vitamin C present in pods. Table no. 3 demonstrated significant variations in treatments regarding the levels of total soluble sugar and vitamin C content, which are quality measures. The highest higher levels of vitamin C content (18.69 mg) are noticed in treatment $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 375) and also produced highest TSS

(3.66$^0$Brix) which was superior over the other treatments. These results are closely confined with the findings of Thirunavukkarasu and Balaji, (2015) [4].

**Table 1:** Effect of organic manures and inorganic fertilizers on number of days to germination, germination percentage, plant height and shoot length of okra.

| Treatment No. | Treatment Combinations | Number of days to germination | Germination percentage (%) | Shoot length (cm) | Root length (cm) |
|---|---|---|---|---|---|
| $T_1$ | (Control + TMOH 2366) | 16.53 | 58.60 | 10.80 | 4.02 |
| $T_2$ | (FYM-15 t/ha + TMOH 2366) | 16.47 | 63.27 | 12.53 | 4.90 |
| $T_3$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 2366) | 12.40 | 60.73 | 17.41 | 7.30 |
| $T_4$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + TMOH 2366) | 15.00 | 62.47 | 14.03 | 5.94 |
| $T_5$ | (Control + Okra 2361) | 13.73 | 66.13 | 16.42 | 6.65 |
| $T_6$ | (FYM-15 t/ha + Okra 2361) | 15.00 | 65.00 | 17.15 | 6.55 |
| $T_7$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra 2361) | 13.07 | 72.80 | 15.26 | 5.69 |
| $T_8$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra 2361) | 15.60 | 68.60 | 17.48 | 7.00 |
| $T_9$ | (Control + Okra TMOH 375) | 10.40 | 80.47 | 18.90 | 7.60 |
| $T_{10}$ | (FYM-15 t/ha + Okra TMOH 375) | 10.27 | 77.27 | 20.07 | 8.70 |
| $T_{11}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra TMOH 375) | 9.13 | 82.70 | 21.57 | 10.47 |
| $T_{12}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra TMOH 375) | 11.80 | 79.13 | 18.40 | 7.96 |
| $T_{13}$ | (Control + okra check variety Samrat) | 15.87 | 75.73 | 15.54 | 5.30 |
| $T_{14}$ | (FYM-15 t/ha okra check variety Samrat) | 14.07 | 74.00 | 16.22 | 5.50 |
| $T_{15}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + okra check variety Samrat) | 9.60 | 81.73 | 20.50 | 9.92 |
| $T_{16}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + okra check variety Samrat) | 11.33 | 73.13 | 19.13 | 9.65 |
| | F-test | S | S | S | S |
| | CD at 5 % | 1.01 | 1.19 | 1.10 | 0.76 |
| | S.E (d)± | 0.49 | 0.58 | 0.54 | 0.37 |

**Table 2:** Effect of organic manures and inorganic fertilizers on seedling length, dry weight of seedling, width of pod and length of pod of okra.

| Treatment No. | Treatment Combinations | Seedling length (cm) | Plant height (cm) | Width of pod | Length of pod |
|---|---|---|---|---|---|
| $T_1$ | (Control + TMOH 2366) | 14.82 | 79.18 | 0.80 | 5.50 |
| $T_2$ | (FYM-15 t/ha + TMOH 2366) | 17.43 | 81.18 | 1.68 | 6.83 |
| $T_3$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 2366) | 24.72 | 80.62 | 1.34 | 7.67 |
| $T_4$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + TMOH 2366) | 19.97 | 82.10 | 1.23 | 7.13 |
| $T_5$ | (Control + Okra 2361) | 23.07 | 84.05 | 1.40 | 8.30 |
| $T_6$ | (FYM-15 t/ha + Okra 2361) | 23.71 | 85.85 | 2.13 | 8.10 |
| $T_7$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra 2361) | 20.95 | 86.35 | 1.94 | 12.53 |
| $T_8$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra 2361) | 24.48 | 82.88 | 2.69 | 8.20 |
| $T_9$ | (Control + Okra TMOH 375) | 26.50 | 84.21 | 2.59 | 10.47 |
| $T_{10}$ | (FYM-15 t/ha + Okra TMOH 375) | 28.77 | 89.21 | 2.32 | 8.70 |
| $T_{11}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra TMOH 375) | 32.03 | 92.46 | 4.45 | 14.30 |
| $T_{12}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra TMOH 375) | 26.36 | 89.42 | 1.92 | 11.63 |
| $T_{13}$ | (Control + okra check variety Samrat) | 20.84 | 86.62 | 2.28 | 9.17 |
| $T_{14}$ | (FYM-15 t/ha okra check variety Samrat) | 21.72 | 82.40 | 2.16 | 9.57 |
| $T_{15}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + okra check variety Samrat) | 30.42 | 90.21 | 2.90 | 12.23 |
| $T_{16}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + okra check variety Samrat) | 28.78 | 86.81 | 3.88 | 13.13 |
| | F-test | S | S | S | S |
| | CD at 5 % | 1.09 | 1.54 | 0.42 | 0.88 |
| | S.E (d)± | 0.53 | 0.76 | 0.21 | 0.43 |

**Table 3:** Effect of organic manures and inorganic fertilizers on yield per plant, yield tonnes per hectare, TSS and vitamin C of okra.

| Treatment No. | Treatment Combinations | Yield per plant (g) | Yield tonnes per hectare (t) | TSS ($^0$Brix) | Vitamin C (mg) |
|---|---|---|---|---|---|
| $T_1$ | (Control + TMOH 2366) | 74.53 | 13.80 | 1.11 | 10.62 |
| $T_2$ | (FYM-15 t/ha + TMOH 2366) | 79.72 | 14.76 | 2.00 | 12.31 |
| $T_3$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 2366) | 95.39 | 17.66 | 1.44 | 11.32 |
| $T_4$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + TMOH 2366) | 91.67 | 16.98 | 1.73 | 11.79 |
| $T_5$ | (Control + Okra 2361) | 85.37 | 15.81 | 2.23 | 13.62 |
| $T_6$ | (FYM-15 t/ha + Okra 2361) | 85.96 | 15.92 | 2.53 | 13.21 |
| $T_7$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra 2361) | 115.23 | 21.34 | 2.54 | 16.60 |
| $T_8$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra 2361) | 96.52 | 17.87 | 2.00 | 11.67 |
| $T_9$ | (Control + Okra TMOH 375) | 83.19 | 15.41 | 2.67 | 16.47 |
| $T_{10}$ | (FYM-15 t/ha + Okra TMOH 375) | 117.46 | 21.75 | 3.06 | 17.14 |
| $T_{11}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + Okra TMOH 375) | 143.56 | 26.58 | 3.66 | 18.69 |
| $T_{12}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + Okra TMOH 375) | 107.57 | 19.92 | 2.15 | 17.48 |
| $T_{13}$ | (Control + okra check variety Samrat) | 79.27 | 14.68 | 2.18 | 14.97 |
| $T_{14}$ | (FYM-15 t/ha okra check variety Samrat) | 100.98 | 18.70 | 2.15 | 15.76 |
| $T_{15}$ | (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + okra check variety Samrat) | 100.21 | 18.56 | 2.47 | 15.42 |
| $T_{16}$ | (NPK-50% + FYM-10 t/ha + V.C.-2.5 t/ha + okra check variety Samrat) | 125.00 | 23.15 | 3.18 | 17.82 |
| | F-test | S | S | S | S |
| | CD at 5 % | 9.57 | 1.77 | 0.33 | 0.69 |
| | S.E (d)± | 4.69 | 0.87 | 0.16 | 0.34 |

## Conclusion

From the above findings it is concluded that the combination of $T_{11}$ (NPK-50% + FYM-15 t/ha + V.C.-5 t/ha + TMOH 375) resulted in maximum growth, yield and quality attributes in Okra under Allahabad Agro climatic condition. The current study demonstrates that the use of more organic materials results in a higher concentration of leftover nutrients, which greatly contributes to maintaining soil productivity over an extended period. The application of increased amounts of organic materials resulted in enhanced values of organic matter.

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