Impact of Organic Amendments on the Growth and Yield of Okra (*Abelmoschus esculentus*) in Udayapur, Nepal

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ABSTRACT

Background: Okra (*Abelmoschus esculentus*) is an important vegetable crop widely cultivated in tropical and subtropical regions due to its nutritional, economic and dietary value. Its growth and yield are strongly influenced by soil fertility, nutrient availability and crop management practices. Evaluating the effects of different organic amendments on okra is therefore important for identifying sustainable soil fertility management practices that can enhance crop growth and yield while reducing dependence on synthetic fertilizers.

Methods: This study, conducted at Triyuga-4, Bagaha, Gaighat, Udayapur, Nepal, from January to June 2022, aimed to evaluate the effects of different organic manures on the growth and yield of okra. The field experiment employed a Randomized Complete Block Design with three replications, examining seven treatments: Control, Farmyard Manure (FYM), Vermicompost, Kishanzyme, Neem cake, Vermicompost + Kishanzyme and Vermicompost + Neem cake + FYM. Variables analyzed included growth parameters (plant height, number of leaves and number of branches), fruit characteristics (fruit length, fruit weight and average fruit weight) and yield parameters (days to first picking, yield and number of pickings).

Result: The findings revealed a significant impact of organic manure on okra yield. Vermicompost treatment had the highest yield (569.37 kg/ha), followed by FYM (458.01 kg/ha), Kishanzyme and the control. Vermicompost notably enhanced growth parameters, including plant height, days to first picking, fruit length, weight, average fruit weight and overall yield. In the control treatment, okra showed moderate growth and yield across various parameters, including plant height (30.63 cm at 60 days after sowing (DAS), number of leaves (30.07 at 60 DAS) and yield (338.80 kg/ha), serving as a baseline for comparison with organic manure treatments. The study highlights that Vermicompost and FYM significantly improve okra production, offering valuable insights for sustainable agricultural practices in Eastern Nepal and recommending their use to farmers in the Udayapur region and elsewhere with similar climates and landscapes globally.

Key words: Farmers, Fertilizers, Organic manure, Vermicompost, Yield.

INTRODUCTION

Nepal, a land of diverse climates and rich biodiversity, hosts over 7,000 plant species. Among 599 food plant species, 400 are horticultural, with 200 being vegetable crops. About 50 of these vegetable species are cultivated (Pandey *et al.*, 2017). Vegetables, the fresh and edible parts of herbaceous plants, are crucial for health and disease prevention. They provide essential nutrients that help build and repair the body and maintain its alkaline balance. Rich in carbohydrates, vitamins and minerals, vegetables like roots, stems, leaves, fruits and seeds offer unique dietary benefits (Rumeza Hanif *et al.*, 2006). In Nepal, the main vegetable crops include cauliflower, cabbage, radish, okra, chili, eggplant, carrot, turnip, broadleaf mustard, Swiss chard, spinach, sweet pepper, cucurbits, beans, peas, onion and garlic. About 65.7% of Nepal's total population is involved in agriculture, contributing 31.3% to the country's GDP (Poudel, 2023). However, the productivity of horticultural crops in Nepal differs from that of its two neighboring countries, China and India (Thapa and Dhimal, 2017). Vegetable productivity in Nepal lags behind that of other countries, mainly due to farmers' limited awareness of various management practices (Gurau and Ray, 2024). The vegetable sector in Nepal has grown rapidly over the last 10 years, primarily through producers diversifying away from the staple crops. However, a slight growth in yield has also contributed to growth. The area of production and total production of vegetables in 2022/23 was 302135 ha and 4376077 Mt in Nepal (Diary, 2022).

Okra (*Abelmoschus esculentus* (L.) Moench) is a well-known annual vegetable crop in the Malvaceae family (Deepthi *et al.*, 2024). It originated in tropical America and was first cultivated in Egypt in the 12th century (Maurya *et al.*, 2013; Khandaker *et al.*, 2017; Pandit *et al.*, 2018). It is also known as lady's fingers, bhindi, bamia, ochro, or gumbo, is a flowering plant in the mallow family. It is best grown in

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a warm climate in tropical and subtropical regions and its production is low in waterlogging, frost and drought conditions (Binalfew and Alemu, 2016; Sachan *et al.*, 2017; Mehata *et al.*, 2022). It is cultivated mainly for its leaves, fruit and seeds, prized for their viscosity, which aids in consuming bulky foods easily. The green pods are noted for their high antioxidant content and ability to stabilize blood sugar levels (Olowokere *et al.*, 2021). Okra is nutritionally significant, providing calcium, magnesium, iron, phosphorus, protein and vitamins A, C (including riboflavin), B6 and K. It is rich in mucilage and serves as a traditional nutrient-dense vegetable, offering minerals like calcium and iron that support various physiological functions in the body (Aboyeji *et al.*, 2021; Silwal *et al.*, 2023). The mucilage found in okra can be used as a plasma substitute or blood (Gayathri and Krishnaveni, 2015; SHARMA *et al.*, 2016). Most okra is consumed, cooked, or processed, though young fruits can be eaten raw. Okra seeds are also utilized for oil extraction, with oil content comparable to that found in poultry eggs and soybeans (Anal *et al.*, 2018). India is the largest producer of Okra in the world. It is one of Nepal's most important vegetable crops, widely cultivated in Jhapa, Morang, Saptari, Bara, Chitwan, Rautahat, Kailali and Dhanusa (Pandit *et al.*, 2018). The production of okra varies from plant to plant based on factors such as soil structure, fertilizer application, intercultural operations, water application and disease control methods. It thrives best at temperatures between 25°C and 30°C in sandy-clay soil with a pH of 6 to 7, under either rainfed or irrigated conditions (Mehata *et al.*, 2022). The growth, yield and quality of okra are hindered by insufficient knowledge of best management practices and low awareness of its nutritional and health benefits (Bake *et al.*, 2017; Pandit *et al.*, 2018).

Ensuring sustainable agricultural production while preserving soil and environmental health is a global challenge (Rana *et al.*, 2026). Inorganic fertilizers can enhance crop yields (Agiragac, 2026), soil pH, total nutrient content and availability, especially in tropical soils with poor fertility and erosion issues (Atijegbe *et al.*, 2014) . However, the indiscriminate use of inorganic fertilizers has led to reduced nutrient uptake, poor vegetable quality and the deterioration of soil health (Basfore *et al.*, 2018; Ram, 2018). In this context, biofertilizers are emerging as an environmentally friendly, cost-effective and sustainable alternative to synthetic fertilizers. They enhance agricultural productivity while minimizing environmental pollution (Kawalekar, 2013; Garcia-Gonzalez and Sommerfeld, 2016; Gurau *et al.*, 2025). Okra, which produces fruit over an extended period, requires a balanced and adequate supply of nutrients to achieve higher yields and better quality (Smriti and Ram, 2018). Therefore, in recent years, organic fertilizers have gained significant attention from environmentalists, agriculturists and consumers alike (Chang EdHaun *et al.*, 2007). The use of organic manures, such as Farm Yard Manure (FYM), Vermicompost (VC), Poultry Manure (PM) and Neem cake (NC) is instrumental in achieving sustainable agriculture. This organic manure positively impacts soil texture and water-holding capacity while also nourishing soil microorganisms (Adhikari and Piya, 2020). The nutritional quality of okra can be enhanced by organic fertilizers like poultry manure and liquid seaweed, which contain 7.39% carbohydrates, 28.04% protein and dietary fiber (Zodape *et al.*, 2009; Okee and Ikabi, 2021). Organic manures have been shown to enhance growth and yield, as well as yield-contributing attributes in okra. This indicates that organic nutrient sources improve economic yield by supplying essential nutrients over an extended period (Tiamiyu *et al.*, 2012; Tanveer *et al.*, 2021). Studies have shown that applying vermicompost and poultry manure boosts yield and growth in okra. However, poultry manure also seems to encourage the intensive use of chemical fertilizers in agriculture (Khandaker *et al.*, 2017). Earthworm manure is known to counteract the harmful effects of chemical fertilizers, improve soil properties and promote crop growth (Bhandari *et al.*, 2019). A field experiment in 2006-2007 found that applying 60% of the recommended NPK dose with neem cake, vermicompost, Azotobacter and phosphate-solubilizing bacteria yielded the highest output and benefit-to-cost ratio (Kumar *et al.*, 2021). Plant-based manures such as mustard oil cakes, sesame oil cakes, neem cakes, peanut cakes and castor cakes promote plant growth and increase yield by reducing the incidence of phytonematodes (Kankam *et al.*, 2015; Sumbul *et al.*, 2015; Bhandari *et al.*, 2019). A study by showed that 100% NPK and 100% Neem cake significantly improved soil physico-chemical parameters, including bulk density, particle density, pore space, water holding capacity, pH, EC, organic carbon and availability of nitrogen, phosphorus and potassium. A study conducted during the rainy season in subtropical Jammu found that applying FYM at 20 t/ha during final land preparation, combined with vermicompost at 2.5 t/ha as a top dressing after the first weeding and thinning, significantly improved all biometric parameters of organically maintained okra (Kumar *et al.*, 2022). Therefore, this study aims to assess the impact of various organic manures on the growth and yield of okra by providing valuable insights for optimizing agricultural practices and promoting sustainable okra production in Udayapur, Eastern Nepal. This study investigates the effects of various organic manures, including vermicompost, Farmyard Manure (FYM), Neem cake, kishanzyme and their combinations, on the growth and yield of okra at different growth stages. By evaluating parameters such as plant height, leaf count, branch development, fruit characteristics and overall yield, the research aims to determine the most effective organic manure treatments for optimizing crop productivity. The findings provide critical insights into en-hancing agricultural practices, advocating for adopting organic inputs and fostering sustainable okra production. These results offer eco-friendly fertilization strategies for farmers in Udayapur and contribute to the broader discourse on sustainable farming practices in comparable agroecosystems. By bridging the gap between traditional farming methods and sustainable agricultural innovations, this study highlights the transformative potential of organic manures to boost crop yields while safeguarding environmental integrity.

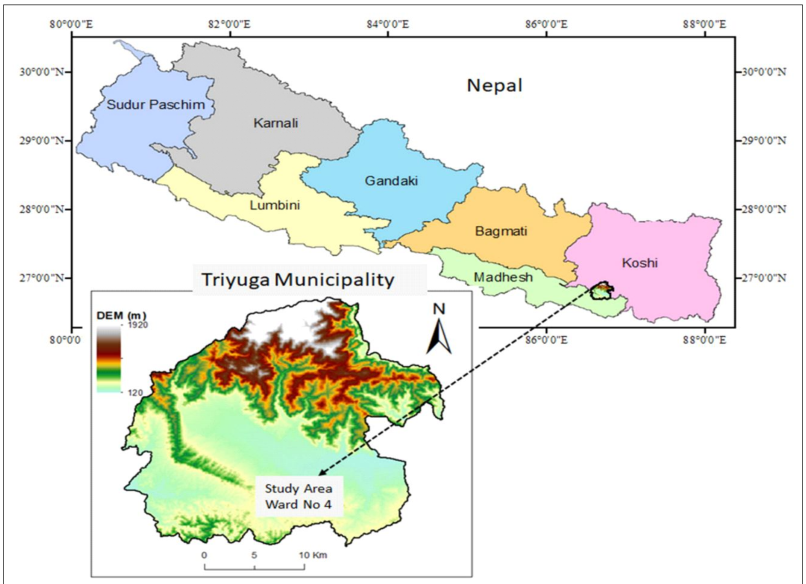
MATERIALS AND METHODS

Experimental site

The study site was Triyuga-4, Bagaha, Gaighat, which was the working area of the Agriculture Knowledge Center Udayapur, Nepal. The study site has the coordinates of 26°47′37″ N and 86°40′17″ E with an elevation of 360 m from sea level (Fig 1). Baseline soil analysis was conducted prior to the experiment to determine pH and available NPK contents. Composite soil samples were collected randomly from seven spots at a depth of 10 cm in a Z-shaped pattern to analyze the physico-chemical properties of the soil. The soil of Udayapur was sandy loam with good drainage, moderately acidic (pH 5.5-6.5) and exhibited moderate fertility levels, forming the basis for comparing the effects of organic amendments on okra growth and yield." The climate of the research site was characterized by three distinct seasons, namely rainy monsoon (June-October), cool winter (November-February) and hot spring (March-May). The research was conducted from January to June 2022. When sowing seed, the observed temperature was between 20 and 25°C The temperature during the summer season ranged from 33-36°C.

Design of experiment

The design was laid out in a randomized complete block design (RCBD), with three replications of each treatment. The experimental plot was divided into three blocks, each



The study farm is located at Triyuga Municipality of Ward No. 6, Province Koshi, Nepal.

Fig 1: Map of the study area.

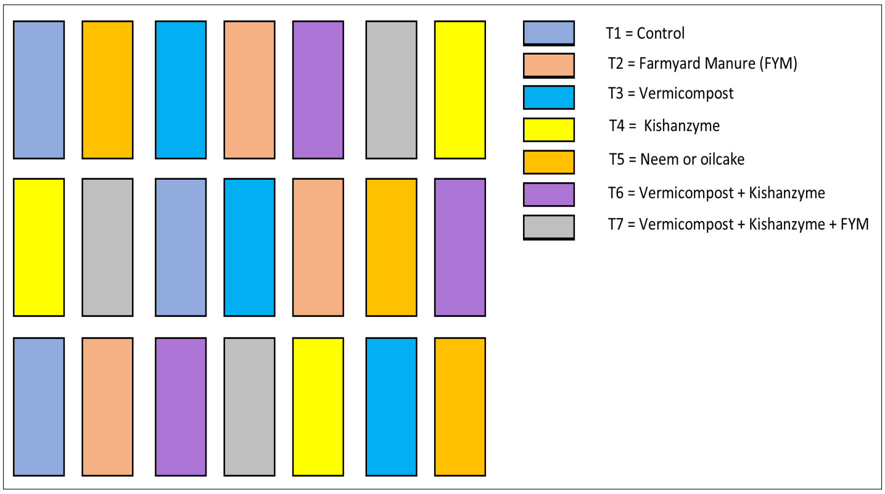


Fig 2: Layout of experimental plots.

with seven plots (Fig 2). Thus, there were 21 (7×3) unit plots altogether. For the facilitation of different intercultural operations, the distance between blocks and plots was kept at 1 m and 0.5 m, respectively. The plot size was 3 m×2 m and the total area covered was 16 m×16.5 m. The treatment was randomly distributed in each experimental plot. Each plot contained four rows and each row contained six plants. Five plants were taken as sample plants.

Treatments and replications

The okra variety Arka Anamika was selected for cultivation in the field during the summer season. Seven treatments were allocated and each treatment was replicated three times in the experimental plot for sustainable vegetable production (Fig 2), Treatment 1: Control, Treatment 2: Farmyard Manure (FYM), Treatment 3: Vermicompost, Treatment 4: Kishanzyme, Treatment 5: Neem cake, Treatment 6: Vermicompost + Kishanzyme and Treatment 7: Vermicompost + Neem cake + FYM.

Cultural practices

The experimental field underwent thorough preparation, including deep plowing with a tractor, harrowing, removal of stubble and weeds, leveling with the removal of rocks and layout according to a designated plan using ropes to create 21 plots. Different organic manures, 20 tons of well-rotted FYM per hectare, 5 tons of Vermicompost, 5 tons of Kishanzyme and 2 tons of Neem cake, were incorporated into the seed sowing areas. The okra variety Arka Anamika was selected for cultivation during the summer season. The seeds were procured from Koshi Agro Traders, Biratnagar, ensuring varietal purity. Different organic amendments such as Vermicompost and Neem cake were obtained from Koshi Agro Traders, Biratnagar as well, while the remaining amendments, including FYM and Kishanzyme, were collected locally from Srijana Agrovet Centre, Udayapur. Kishanzyme, composed of fermented fruit and vegetable wastes and formulated as granules, contains beneficial microorganisms, enzymes and trace nutrients. It was included in this study to assess its role as a biotechnological soil amendment for enhancing soil enzymatic activity and microbial health compared to traditional nutrient-based manures. Neem cake acts as a natural fertilizer and pest repellent due to its rich nutrient content (N, P, K) and bioactive compounds such as azadirachtin and nimbin. It enhances soil fertility, stimulates microbial activity and protects plants from soil-borne pests, leading to improved growth and yield (Abbasi *et al.*, 2005; Campos *et al.*, 2016). Okra seeds were soaked in clean water for 8 hours to promote rapid germination and directly sown at a spacing of 45 cm × 30 cm, maintaining two plants per hill after thinning. Irrigation was applied immediately after germination and subsequently every 3-4 days due to the sandy loam soil's high drainage capacity. Hoeing and weeding were performed at 15-20-day intervals and thinning was conducted once, at 15 days after sowing (DAS), to maintain uniform plant population and growth. Plant protection measures were carried out using locally practiced organic methods. A cow milk-to-water mixture (1:2 ratio) was sprayed at 10-day intervals to prevent yellow mosaic virus infection. Neem cake (commercial neem-based formulation containing 300 ppm azadirachtin) was applied at the recommended rate of 3 mL per liter of water to control cutworms. Yellow sticky traps were installed at 10 traps per 100 m^2 area to manage hopper populations.

Data collection

In this experimental study, a range of agronomic parameters were measured to evaluate the effectiveness of different treatments. Plant height (cm) was recorded from five randomly selected plants within the net plot area at 30, 45 and 60 days after sowing (Rumeza *et al.,* 2006), using a measuring scale from the plant base to the apex. The number of leaves per plant was counted at the same intervals from the same sample plants. The number of fruits per plant was documented through regular harvesting of fruits from the five sample plants. Fruit length (cm) was measured using a scale during each harvest. The number of branches per plant was counted at 45 and 60 DAS from the sample plants. The days to first picking were recorded based on the initial fruit harvest from the five sample plants. Individual fruit weight (g) was determined using a digital weighing scale and average fruit weight (g) was calculated accordingly. Finally, total fruit yield was assessed and expressed in kilograms per hectare (kg/ha), providing a comprehensive evaluation of treatment impacts on crop productivity.

Data analysis and interpretation

The measured data were systematically arranged on the basis of various observed parameters. Statistical package R programming was used to analyze data of different parameters collected during the experiment. Means were compared at 95% probability using Fishers protected LSD test.

RESULTS AND DISCUSSION

Biometrical observation

Plant height (cm)

In our study, we assessed the effect of various organic manures on the plant height of okra across different growth stages. At 30 and 45 days after sowing (Rumeza *et al.,* 2006), no significant differences in plant height were observed among treatments, with an overall mean plant height of 18.52. The tallest plants were found in the Vermicompost treatment (23.80 cm), which was statistically similar to FYM (18.73 cm), Neem cake (18.67 cm), Vermicompost + Neem cake + FYM (18.33 cm), Vermicompost + Kishanzyme (18.07 cm), Control (17.73 cm) and Kishanzyme (14.27 cm). In contrast, the shortest plants were observed in the Kishanzyme treatment (14.27 cm). By 45 DAS, plant height increased across all treatments, with an overall mean of 27.18. Vermicompost (30.67 cm) and FYM (29.27 cm) produced the tallest plants, followed by Control (28.33 cm), Neem cake (27.53 cm), Vermicompost + Neem cake + FYM (26.93 cm), Vermicompost + Kishanzyme (26.27 cm) and Kishanzyme (21.27 cm). Once again, the shortest plants were found in the Kishanzyme treatment (21.27 cm). At 60 DAS, significant differences in plant height were observed, with an overall mean plant height of 33.78.The tallest plants recorded in the Vermicompost + Neem cake + FYM treatment (39.20 cm), followed by Neem cake (39.00 cm), Vermicompost (37.00 cm), FYM (35.133 cm), Control (30.633 cm), Vermicompost + Kishanzyme (29.867 cm) and Kishanzyme (25.60 cm). Again, the shortest plants were observed in the Kishanzyme treatment (25.60 cm) (Table 1).

The results revealed that Vermicompost consistently promoted taller plant growth across growth stages, likely due to its rich nutrient content, improved soil structure and enhanced microbial activity that together support efficient nutrient uptake and root development (Gutiérrez-Miceli *et al.*, 2007). Our findings align with previous research where Vermicompost demonstrated high plant height, although some studies reported FYM as the dominant amendment (Alam *et al.*, 2019). Furthermore, our findings are consistent with the results reported by (Toor *et al.*, 2023; Toor *et al.*, 2024), which emphasized the positive impact of Vermicompost on plant growth.

Leaf number

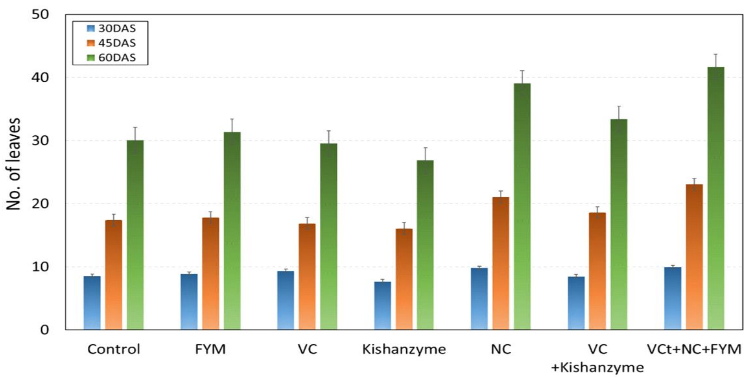
No significant difference was observed at 30 DAS, 45 DAS and 60 DAS. At 30 DAS, the highest number of leaves was recorded in the Vermicompost + Neem cake + FYM treatment (9.93), followed by Neem cake (9.80), Vermicompost (9.33), FYM (8.87), Control (8.53), Vermicompost + Kishanzyme (8.47) and Kishanzyme (7.67), respectively (Fig 3). Similarly, although non-significant at 45 DAS, the treatments showed the highest number of leaves in Vermicompost + Neem cake + FYM (23.067), Neem cake (21.067), Vermicompost + Kishanzyme (18.60), FYM (17.80), Control (17.40), Vermicompost (16.87) and Kishanzyme (16.07), respectively. At 60 DAS, the number of leaves was highest in Vermicompost + Neem cake + FYM (41.67), followed by Neem cake (39.067), Vermicompost + Kishanzyme (33.40), FYM (31.40), Control (30.067), Vermicompost (29.53) and Kishanzyme (26.87), respectively.

This study recorded the highest number of leaves per plant using Vermicompost + Neem cake + FYM treatment.

Table 1: Effect of different organic manures on the plant height of okra.

Treatment	Plant height		
	30 DAS	45 DAS	60 DAS
Control	17.73^{ab}	28.33^{a}	30.63^{abc}
FYM	18.73^{ab}	29.27^{ab}	35.13^{ab}
Vermicompost	23.80^{a}	30.67^{a}	37.00^{ab}
Kishanzyme	14.27^{b}	21.27^{b}	25.60^{c}
Neem cake	18.67^{ab}	27.53^{ab}	39.00^{a}
Vermicompost + Kishanzyme	18.07^{ab}	26.27^{ab}	29.87^{bc}
Vermicompost + Neem cake + FYM	18.33^{ab}	26.93^{ab}	39.20^{a}
LSD	6.41^{ns}	8.41^{ns}	8.27*
Sem ±	2.09	2.73	2.69
CV%	19.48	17.39	13.74
Mean	18.52	27.18	33.78

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns=Non-significant.



VC = Vermicompost; NC = Neem cake; FYM = Farmyard manure.

Fig 3: Effect of different organic manures on the leaf number of okra.

A previous study by Kumar *et al.* (2022) indicated that the highest number of leaves per plant and leaf width were observed under the combined application of organic manures and bio-fertilizers, specifically in treatment T6 (Vermicompost at 5 t/ha + Azotobacter). Similarly, (Gutiérrez-Miceli *et al.*, 2007) observed that the addition of vermicompost had no significant effect on the number of leaves 85 days after transplanting, suggesting that growth responses to vermicompost application may vary with crop type and growing conditions.

Branch number

The effect of different organic manures on the number of branches of okra is shown in Fig 4. There was no significant difference observed at 45 DAS; the highest number of branches was observed in Vermicompost + Neem cake + FYM (2.67), followed by Neem cake (2.43), Kishanzyme (2.267), Vermicompost + Kishanzyme (2.183), Vermicompost (2.13) and Control, FYM (2.067). Similarly, although non-significant at 60 DAS, the treatments showed the highest number of branches in Vermicompost + Neem cake + FYM (4.13), followed by Neem cake (3.60), Vermicompost + Kishanzyme (3.067), FYM (2.93), Control (2.40), Kishanzyme (2.35) and Vermicompost (2.33), respectively.

The highest number of branches in okra observed with the Vermicompost + Neem cake + FYM treatment is likely due to the combined benefits of improved nutrient availability, enhanced microbial activity, better soil structure and water retention, pest and disease resistance and the presence of growth-promoting substances. This combination provides a balanced and diverse nutrient profile, promotes beneficial microbial populations, improves soil conditions and reduces plant stress, leading to better overall plant health and growth. On the other hand, as expected, controlled plots showed the lowest branch numbers due to a lack of enough nutrients. Supporting this, (Dessai *et al.*, 2024) reported that treatment 120:60:50 kg NPK + 25 t FYM + 6 t Vermicompost showed the highest number of branches per plant. Their findings indicated that both organic manures and their mixtures with full NPK significantly increased the growth and total yield attributes of okra. Therefore, these experiments provide a clear pathway for farmers and growers to choose appropriate soil amendments that enhance plant growth and yield.

Day of first picking

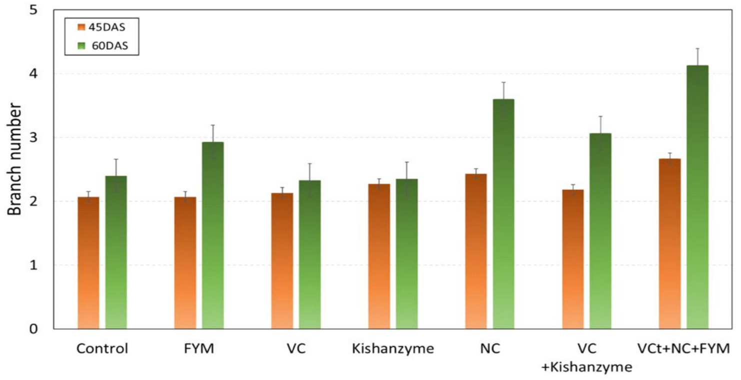
The effect of different organic manures on days to first harvest is presented in Table 2. Significant differences were observed in the days to the first harvest. The mean values indicate that the earliest days to first harvest were observed in the Vermicompost treatment (44.53 days), while treatments Vermicompost + Kishanzyme, FYM, Kishanzyme and Control had similar durations (44.93 days). The Vermicompost + Neem cake + FYM treatment required the longest period to reach the first harvest (48.178 days). Specifically, the Neem cake treatment required more days to reach the first harvest compared to the Vermicompost, Vermicompost + Kishanzyme + FYM, Kishanzyme and Control treatments, respectively.

The early maturity observed in the Vermicompost treatment may be attributed to its balanced nutrient composition, particularly the readily available nitrogen, phosphorus and potassium, along with plant growth-

Table 2: Effect of different organic manures on the day of first picking.

Treatment	DOFP
Control	44.93[b]
FYM	44.93[b]
Vermicompost	44.53[b]
Kishanzyme	44.93[b]
Neem cake	48.6[a]
Vermicompost+Kishanzyme	44.93[b]
Vermicompost+Neem cake+FYM	48.18[a]
LSD	1.47***
SEm±	0.47
CV%	1.81
Mean	45.87

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns= Non-significant.



VC= Vermicompost; NC= Neem cake; FYM= Farmyard manure.

Fig 4: Effect of different organic manures on the number of branches in okra.

promoting substances such as humic acids and beneficial microorganisms (Tognetti *et al.*, 2005; Aslam *et al.*, 2019; Oyege and Balaji Bhaskar, 2023). These components enhance root development, accelerate vegetative growth and promote early flowering and fruit set. Additionally, vermicompost improves soil aeration, microbial activity and enzymatic processes (Bianco *et al.*, 2022; Oyege and Balaji Bhaskar, 2023), creating favorable conditions for faster physiological development of okra plants. Furthermore, the application of vermicompost as a partial substitute for synthetic fertilizers has been shown to stimulate plant production and promote early flowering and fruit development (Rehman *et al.*, 2023). Steffen *et al.* (2019) reported that replacing 40-50% of synthetic fertilizers with vermicompost in tomatoes resulted in earlier flowering, higher fruit mass and improved yield performance, supporting the present findings on okra.

Number of pickings per plant

The effect of different organic manures on the number of pickings per plant is presented in Table 3. No significant difference was observed in the number of pickings per plant. The mean values show that the highest number of pickings per plant was observed in the Vermicompost treatment (9.53), which was statistically similar to Kishanzyme (8.67), FYM (8.20), Control (7.73), Vermicompost + Kishanzyme (7.67), Neem cake (7.40) and Vermicompost + Neem cake + FYM (7.33), respectively.

Fruit weight

The effect of different organic manures on the fruit weight of okra is presented in Table 4. Significant differences were observed in fruit weight among treatments. The mean values indicate that the highest fruit weight (135.56 gm) was recorded in the Vermicompost treatment, which was statistically similar to the FYM treatment (109.05 gm), Kishanzyme treatment (89.37 gm), Control (80.67 gm), Vermicompost + Kishanzyme treatment (80.34 gm), Vermicompost + Neem cake + FYM treatment (77.01 gm) and Neem cake treatment (75.95 gm), respectively. The lowest fruit weight was observed in the Neem cake treatment (75.95 gm).

Fruit length

The effect of different organic manures on the fruit length of okra is presented in Table 5. Significant differences were observed in fruit length among treatments. The mean values indicate that the longest fruit length (12.08 cm) was recorded in the Vermicompost treatment, which was statistically similar to the FYM treatment (11.56 cm), Vermicompost + Neem cake + FYM treatment (9.33 cm), Kishanzyme treatment (9.24 cm), Control (9.22 cm), Vermicompost + Kishanzyme treatment (9.03 cm) and Neem cake treatment (9.03 cm), respectively. The shortest fruit length was observed in the Neem cake treatment (9.03 cm), with Vermicompost + Kishanzyme treatment showing similar results.

Table 3: Effect of different organic manures on number of pickings per plant.

Treatment	NOPPP
Control	7.73[ab]
FYM	8.2[ab]
Vermicompost	9.53[a]
Kishanzyme	8.67[ab]
Neem cake	7.40[b]
Vermicompost+Kishanzyme	7.67[ab]
Vermicompost+Neem cake+FYM	7.33[b]
LSD	1.86[ns]
SEm±	0.61
CV%	12.88
Mean	8.08

***Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns= Non-significant.

Table 4: Effect of different organic manure on fruit weight of Okra.

Treatment	Fruit weight
Control	80.67[bc]
FYM	109.06[ab]
Vermicompost	135.56[a]
Kishanzyme	89.34[bc]
Neem cake	75.95[c]
Vermicompost+Kishanzyme	80.34[bc]
Vermicompost+Neem cake+FYM	77.01[c]
LSD	29.26**
SEm±	9.49
CV%	17.78
Mean	92.56

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns= Non-significant.

Table 5: Effect of different organic manures on the fruit length of okra.

Treatment	Fruit length
Control	9.22[b]
FYM	11.56[a]
Vermicompost	12.09[a]
Kishanzyme	9.25[b]
Neem cake	9.03[b]
Vermicompost+Kishanzyme	9.03[b]
Vermicompost+Neem cake+FYM	9.33[b]
LSD	1.75**
SEm±	0.56
CV%	9.87
Mean	9.93

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns= Non-significant.

Average fruit weight

The effect of different organic manures on the average fruit weight of okra is presented in Table 6. Significant differences were observed in average fruit weight among treatments. The mean values indicate that the highest average fruit weight (14.66 g) was observed in the Vermicompost treatment, which was statistically similar to the FYM treatment (13.33 g), Vermicompost + Neem cake + FYM treatment (10.69 g), Vermicompost + Kishanzyme treatment (10.57 g), Kishanzyme treatment (10.54 g), Control (10.46 g) and Neem cake treatment (10.33 g), respectively. The lowest average fruit weight was observed in the Neem cake treatment (10.33 g).

Yield

The effect of different organic manures on yield (kg/ha) is presented in Table 7. Significant differences were observed in yield among treatments. The mean values indicate that the highest yield (569.37 kg/ha) was observed in the Vermicompost treatment, which was statistically similar to the FYM treatment (458.01 kg/ha), Kishanzyme treatment (375.20 kg/ha), Control (338.80 kg/ha), Vermicompost + Kishanzyme treatment (337.47 kg/ha), Vermicompost + Neem cake + FYM treatment (323.74 kg/ha) and Neem cake treatment (319.02 kg/ha), respectively. The Neem cake treatment had the lowest yield (319.02 kg/ha).

Table 6: Effect of different organic manures on the average fruit weight of Okra.

Treatment	AFW
Control	10.46[b]
FYM	13.33[a]
Vermicompost	14.66[a]
Kishanzyme	10.54[b]
Neemcake	10.33[b]
Vermicompost+Kishanzyme	10.57[b]
Vermicompost+Neemcake+FYM	10.69[b]
LSD	2.55*
SEm±	0.83
CV%	12.48
Mean	11.52

*Significant at 0.05 level of significance, ** Significant at 0.01 level of significance, ***Significant at 0.001 level of significance, ns= Non-significant

Table 7: Effect of different organic manures on yield kg/ha of Okra.

Treatment	Yield kg/ha
Control	338.80[c]
FYM	458.01[ab]
Vermicompost	569.37[a]
Kishanzyme	375.20[bc]
Neemcake	319.02[c]
Vermicompost+Kishanzyme	337.47[bc]
Vermicompost+Neemcake+FYM	323.74[c]
LSD	122.79**
SEm±	39.84
CV%	17.76
Mean	388.80

*Significant at 0.05 level of significance, ** Significant at 0.01 level of significance, *** Significant at 0.001 level of significance, ns= Non-significant**.**

The highest yield in the current research was observed with the Vermicompost treatment, likely due to its steady nutrient release and soil health benefits (Enebe and Erasmus, 2023). However, according to (Niraj *et al.*, 2023), the treatment involving 50% recommended N through chemical fertilizer + 50% N through poultry manure (T4) resulted in the highest yield per hectare, indicating that integrating organic and inorganic fertilizers provides complementary benefits for improving soil fertility and productivity. Furthermore, (Khatun *et al.*, 2023) reported that Vermicompost 20 ton/ha was the best treatment for okra cultivation in the coastal region of Bangladesh, with the maximum yield per hectare (17.8 ton/ha). These results further justify that the application of vermicompost at an appropriate rate substantially enhances okra growth and yield due to improved nutrient dynamics, soil structure and biological activity.

CONCLUSION

In conclusion, the results underscore the significant role of Vermicompost and its combinations in enhancing the growth, reproductive performance and yield of okra. These findings have important implications for promoting sustainable farming practices, as organic amendments like Vermicompost can improve soil health, nutrient availability and overall plant productivity. The study highlights that Vermicompost and FYM, in particular, significantly improve okra production, with Vermicompost yielding the highest production (569.37 kg/ha), followed by FYM (458.01 kg/ha), Kishanzyme and the Control (338.80 kg/ha). These results suggest that organic fertilizers can serve as viable alternatives to synthetic fertilizers, fostering environmentally friendly agriculture.

Although this study primarily focused on plant growth and yield parameters, the observed improvements under organic manure treatments suggest potential contributions to soil fertility and structure. Further long-term research is recommended to evaluate these effects on soil physical, chemical and biological properties across different agroecological conditions. In addition, exploring the synergistic effects of integrated nutrient management approaches combining various organic manures and inorganic fertilizers could help optimize nutrient availability, crop yield and sustainability. Furthermore, conducting economic feasibility studies comparing organic and conventional fertilizer use would help farmers make informed decisions regarding cost-effectiveness and productivity. Overall, this study provides valuable insights into the effectiveness of Vermicompost and FYM in boosting okra production, encouraging their widespread adoption in Eastern Nepal and similar agricultural regions globally. Promoting organic manure-based fertilization strategies can contribute significantly to food security, environmental sustainability and the economic well-being of farmers.

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Author contribution statement

Sanjita Gurau did design, conceptualization, writing and formatting. Srijana Chaudhary set up field experiments, collected data and wrote. Ebha Dawadi collected data, laid out the plots and management. Ram L. Ray edited the manuscript and supervised it while writing.

Conflict of interest

There is no conflict of interest.

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