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Effect of Different Organic and Inorganic Fertilizers on the Growth and Yield of Okra

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Abstract

Okra production is thought to be increased by applying inorganic fertilizers; however, continuous application of inorganic fertilizers might cause nutritional imbalance and soil acidity, considering these, a sustainable approaches of okra production would involve managing fertilizers more efficiently using both organic and inorganic fertilizers. With this objective an experiment was evaluated to understand the effectiveness of different types of organic and inorganic fertilizers in promoting the growth and development of Okra plants. The experiment comprised of three replications, six treatments, and one control (untreated). The treatments were: T0 = Control, T1 = recommended Inorganic fertilizers, T2 = Poultry manure, T3 = Tricho-compost, T4 = Vermicompost, T5 = Cowdung and T6 = Cowdung + recommended Inorganic fertilizer. Among the effects of different treatment combinations, Poultry manure (T_2) showed the highest total fruit yield (14.6 tha^{-1}), plant height (99.2cm), individual fruit weight (15.39 g), and fruit length (11.68 cm) and diameter(1.82cm). While, minimum yield (7.65 tha^{-1}), plant height (80.93cm), individual fruit weight (10.67gm), and fruit length (8.47cm) were recorded in T_0. However, compared with other treatment combinations, poultry manure treatment performed better followed by vermicompost. Therefore, it can be concluded that poultry manure performed better for the growth and yield performance of okra.

1. Introduction

Okra (*Abelmoschus esculentus* L) is a significant horticultural crop cultivated in tropical and subtropical regions. It is valued for its various edible parts, including fresh leaves, buds, flowers, pods, stems, and seeds (Adekiya *et al.,* 2020). Commercial production of okra has become a vital summer crop in Bangladesh. When vegetables are scarce in the market, they play a crucial role in meeting the country's demand for vegetables (Shahriazzaman *et al.,* 2014). It belongs to the family Malvaceae and has the typical floral traits associated with this lineage. It was first domesticated in Egypt in the 12th century and is native to tropical Africa (A & A, 2020).

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Okra is packed with essential nutrients such as calcium, zinc, riboflavin, vitamin A, thiamin, vitamin B6, vitamin C, folic acid, and dietary fiber while being low in calories. Okra's mucilage modulates blood sugar absorption in the small intestine, which helps control blood sugar levels. Additionally, they aid in reabsorbing surplus water, cholesterol, metabolic toxins, and bile (Dantas *et al.*, 2021; Romdhane *et al.*, 2020)

Okra has a favorable response to the application of organic manure, demonstrating its efficiency in using fertilizers, which ultimately contributes to its enhanced growth and production (Vikas *et al.*, 2020). NPK fertilizer enhances soil fertility and increases okra yield. However, the high price of NPK fertilizer drives up overall production costs. Also, it is harmful to the ecology. The utilization of organic materials is highly encouraged due to their potential to enhance environmental conditions and minimize the expenses associated with fertilizing crops (Muhammad *et al.*, 2020; Uka *et al.*, 2013). Poultry manure provides essential nutrients like NPK and Zn, which are important for the growth of horticultural crops. It has different content of nitrogen, phosphorus, and potassium averaging 3.03% N, 2.63% P_2O_5, and 1.4% K_2O. Vermicompost, an organic fertilizer, is also nutrient-rich and contains enzymes that decompose organic matter in the soil, making nutrients available to plant roots (Kota *et al.*,2022). Employing copious quantities of inorganic fertilizers to augment crop productivity and optimal growth potential is common in vegetable cultivation. Nevertheless, the exclusive utilization of inorganic fertilizers may give rise to detrimental implications on both human health and the environment. Using chemical fertilizers can exert harmful effects on the soil's overall health (Khandaker *et al.*, 2017; Unagwu & Ayogu, 2022).

Moreover, the escalating cost of inorganic fertilizers poses a growing challenge for agricultural producers with constrained financial means. Implementing organic fertilizers, such as manure, compost, and Vermicompost, is imperative to stimulate and maintain agricultural productivity. This is feasible, provided agrarian producers have the financial capacity to bear the associated costs (Coulibaly *et al.*, 2021). Most of the farmers in Bangladesh need to learn how to apply balanced fertilizers. Therefore, they grow various crops without checking the soil or adjusting the fertilizer levels. To increase their crop yields, many farmers resort to the careless use of chemical fertilizers without supplementing with enough organic manure. In addition to diminishing product quality and longevity, wasteful use of fertilizers may compromise soil health. Using suitable organic manures such as Vermicompost, Tricho-compost, and Farm Yard Manure (FYM) is a highly effective way to prolong the storage life of vegetables, rather than relying on chemical fertilizers (Tarafder *et al.*, 2023).

Research has shown that using vermicompost boosts nutrient levels and soil organic matter, leading to better soil structure and enhanced cation exchange capacity. Earthworms are known to consume organic waste materials as a source of nutrition, and the residual matter expelled by these organisms is commonly referred to as "Vermicompost." Vermicompost functions as an organic fertilizer due to its nutrient content, including nitrogen, phosphate, potassium, and micronutrients, among others (Meena *et al.*, 2019).

Recently, there has been a strong focus on tackling global environmental challenges. One particularly successful approach that has garnered attention is the use of organic wastes, such as vermicompost and poultry manures. The use of vermicompost and poultry manure in a sequential manner has been seen to enhance the yield-related traits and overall yield of okra. This study aims to evaluate how different organic fertilizers, both alone and in combination with recommended synthetic fertilizers, affect okra growth and yield. The objective is to identify the most effective approaches for sustaining high yields, meeting market demand, and preserving soil fertility under given conditions of the environment.

2. Materials and Methods

2.1 Experimental Site and Period

The present study was carried out at the IUBAT Agriculture Research Station (IARS) in Rajendrapur, Gazipur, Dhaka, Bangladesh during May to August 2023. The experimental field is situated at a latitude of 23° 74' and a longitude of 90° 35', with an elevation of 8.2 meters above sea level. The soil is classified within the Agroecological Zone – Madhupur Tract (AEZ 28), which features a tropical climate. The average temperature in the area was 29.13 °C, and the average rainfall 342 mm (Table 1).

Table 1. Meteorological data during the experimental period May-August 2024.

Month	Minimum Temperature (°C)	Maximum Temperature (°C)	Relative Humidity (%)	Average Rainfall (mm)	Sunshine (hrs day^{-1})
May	24.5	32.9	68	339.4	11
June	26.1	32.1	76	340.4	11
July	26.2	32.4	81	373.1	10
August	26.3	32.6	80	316.5	10

Source: Bangladesh Meteorological Departmentn-2023.

2.2 Experimental Materials

The seeds used in this experiment were BARI Okra-2, obtained from the Bangladesh Agricultural Research Institute (BARI) in Gazipur, Dhaka. Vermicompost and Trichocompost were sourced from ACI Fertilizer Company, while poultry manure and cowdung were collected from the livestock shed at IUBAT Agriculture Research Station (IARS) Rajendrapur, Gazipur. Inorganic fertilizers, including Urea, TSP, and MOP, were acquired from a Bangladesh Agricultural Development Corporation (BADC) authorized fertilizer shop at Tongi, Gazipur, Dhaka.

2.3 Soil Sample Collection

Before land preparation, soil samples were collected to assess the physicochemical properties of the soil. The soil samples were collected from a depth of 0 to 15 cm at four different sites of the experimental field.

2.4 Agronomic Practices

At the IUBAT Agriculture Research Station, the land was ploughed and harrowed to achieve a fine tilth, and leveling was carried out with the use of a leveler. Before sowing, the seeds were soaked overnight to enhance germination. To prevent fungal issues, the seeds were treated with Carbendazim fungicides. The seeds were planted in rows at a depth of 2 cm, with two seeds per hole, following a spacing of 30 cm. After 15 days, thinning was done to leave one plant per hole during the first weeding. Weeding was carried out by hand at 15 and 35 days after sowing (DAS) to reduce weed competition. Harvesting involved manually picking the fresh pods two months after sowing.

2.5 Treatment and Experimental Details

The study was conducted using a Randomized Complete Block Design (RCBD) with three replications and seven treatments, including one control group with no fertilizer application. Each experimental plot had an inter-row spacing of 60 cm and a plant-to-plant distance of 30 cm, with a total plot size of 3.77 m².

Table 2. Treatment details.

Treatment	Fertilizer/Manure	Qty. applied/ha
T_0	No Application (Control)	Nil
T_1	Urea, TSP, MOP	65kg, 21kg,33kg (ha)
T_2	Poultry Manure	5 t ha^{-1}
T_3	Tricho-compost	1 t ha^{-1}
T_4	Vermicompost	1 t ha^{-1}
T_5	Cow dung	3 t ha^{-1}
T_6	Cow dung + Urea, TSP, MOP	3 t ha^{-1} +50 kg,15kg,25kg (ha)

Manure and fertilizers were applied following Fertilizer Recommendation Guide 2018 (Ahmmed *et al.,* 2018).

2.6 Data Collection

Twenty (20) days after sowing (DAS), pertinent data of plant height, leaf numbers, per fruit weight, and fruit length and diameter were meticulously collected from a sample size of 5 plants per plot. The fruits were subjected to a harvesting schedule with a frequency of every 5 days, culminating in the fifth harvest. Data were collected on several parameters, including plant height, number of leaves, number of fruits, days to first flowering, individual fruit weight, fruit length, fruit diameter, soil sample analysis, and total yield in tons per hectare.

2.7 Statistical Analysis

The obtained data were analyzed with SPSS software. The ANOVA and t-test were performed using the mentioned software and the significant difference between the means was compared at a 5% level of significance.

3. Results

3.1 Soil Sample Analysis

The physio-chemical properties of the soil were determined by collecting composite soil samples. This included measuring the soil's pH, organic matter content, and levels of total nitrogen (N), phosphorus (P), potassium (K), iron (Fe), zinc (Zn), and electrical conductivity (EC).

Table 3. Soil status before and after experimentation.

Soil properties	Before the application of fertilizer and manure	After the application of fertilizer, manure & harvest of fruit
Soil pH	6.5675	5.49
Organic Matter %	1.74	2.4725
Electrical conductivity (EC)	0.32	0.35
Total Nitrogen(N) %	0.09	0.117
Phosphorus (PPM)	21.6	69.0525
Potassium (meq/100ml)	0.1275	0.2665
Zinc (PPM)	1.115	1.0545
Iron (PPM)	66.075	10.595
Textural Class	Sandy Loam	Loam
Sand %	64	42.31
Silt %	26.28	42.085
Clay %	9.72	15.49

Comparing soil properties before and after the application of organic and inorganic fertilizers showed how the soil had been affected by adding nutrients, as shown in Table 3. The pH of the soil decreased from 6.5675 to 5.49 after the application of fertilizer. This shift towards acidity may influence nutrient availability particularly micronutrient and microbial activity in the soil. After fertilization, the amount of organic matter increased from 1.74% to 2.4725%. This increased suggests increased soil fertility as well as possible improvements to soil structure and water-retention ability. The EC slightly increased from 0.32 to 0.35, suggesting a minor elevation in the concentration of soluble salts in the soil solution.

Following fertilization, nutrient levels underwent significant changes (Table 3): Total nitrogen (N) content surged from 0.09% to 0.117%, indicating heightened nitrogen availability for plant uptake. Phosphorus levels exhibited a remarkable increase from 21.6 to 69.0525 PPM, demonstrating successful soil phosphorus enrichment. Potassium content was also elevated from 0.1275 to 0.2665 meq/100 ml, indicating improved potassium availability for plant nutrition. Meanwhile, zinc levels remained steady, but iron levels notably declined from 66.075 to 10.595 PPM, prompting further investigation into its potential implications for plant health.

The soil transitioned from sandy loam to loam texture, characterized by alterations in sand, silt, and clay percentages. This change may influence soil structure, soil productivity, drainage, and nutrient retention capabilities.

3.2 Plant Height

Data regarding plant height are presented in Figure 1. The differences in plant height among the treatments throughout the experiment were statistically significant. Plant height increased as the experiment progressed. We observed a substantial increase in plant height across the growing period. There was a notable difference in plant height among the treatments at specific times. The tallest plants were found in the T_2 treatment (99.2 cm) at 80 days after sowing, which was statistically comparable to T1, T_3, T_4, T5, and T_6. In contrast, the shortest plant height was recorded in the T_0 treatment (80.93 cm) at the same time.

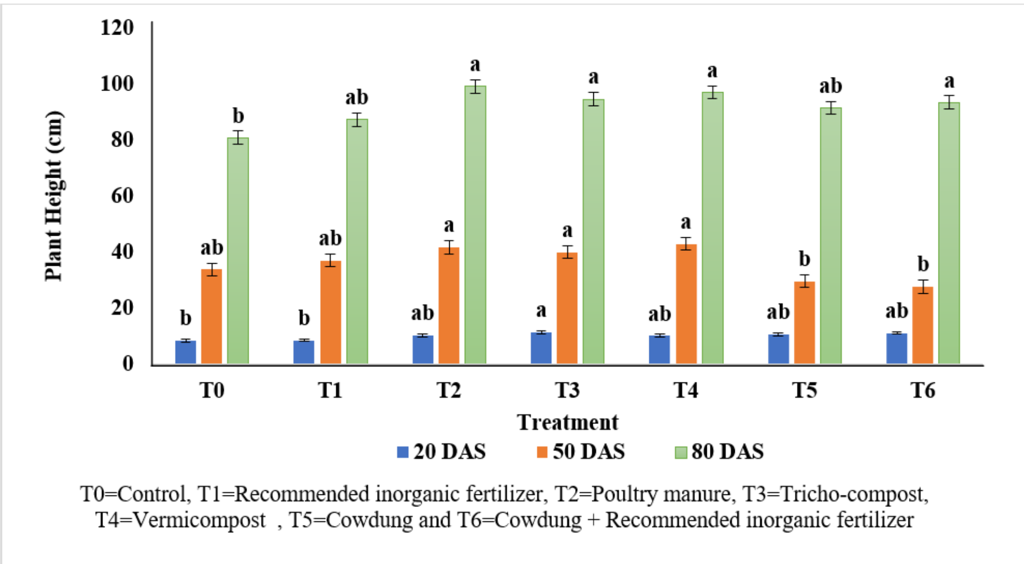

Figure 1: Effect of Different Organic and Inorganic Fertilizers on Plant Height (P.H.) at Different DAS

3.3 Number of Leaves

Figure 2 illustrates the average number of leaves per plant for each treatment at different time points. The experiment's findings showed that, as a result of using various organic and fertilizer sources, there were notable variations among the various treatments. There was a noticeable increase in number of leaves throughout the growing period. Even, there was a noticeable variation among the treatments at the specific time point. Among the different treatment combinations, the maximum number of leaves were observed in the T_4 treatment (38) at 80 days after sowing. This number of leaves was statistically similar to the plant leaves observed in T0, T1, T_2, and T_3 treatments. In contrast, the T_6 treatment had a minimum number of leaves (18.93) at 80 days after sowing, which was statistically similar to T_5.

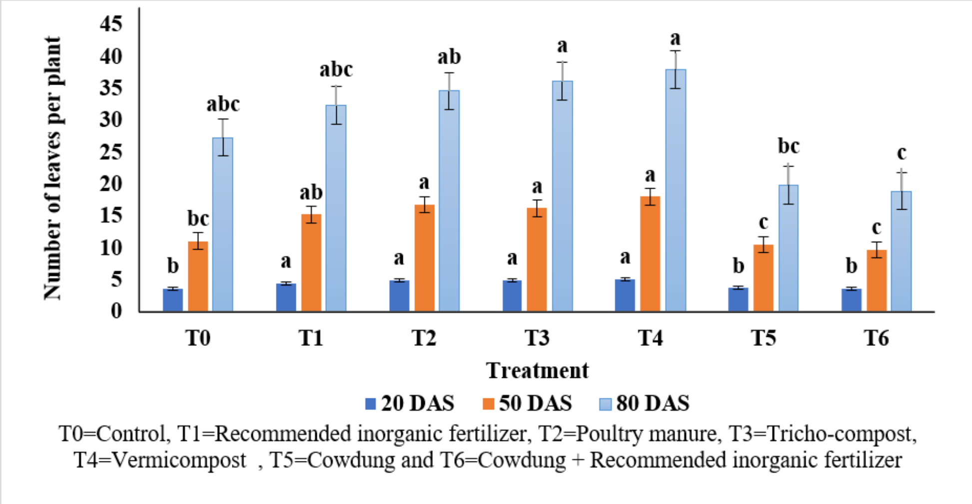

Figure 2: Effect of Different Organic and Inorganic Fertilizers on Number of Leaves (N. L.) at Different DAS

3.4 Days to Emergence of First Flowering:

Among the various levels of organic and inorganic fertilizers, T_6 required the most days to reach first flowering (58.47 days), followed by T_5 and T_1. In contrast, the earliest first flowering occurred in T_4, with a duration of 44.75 days.

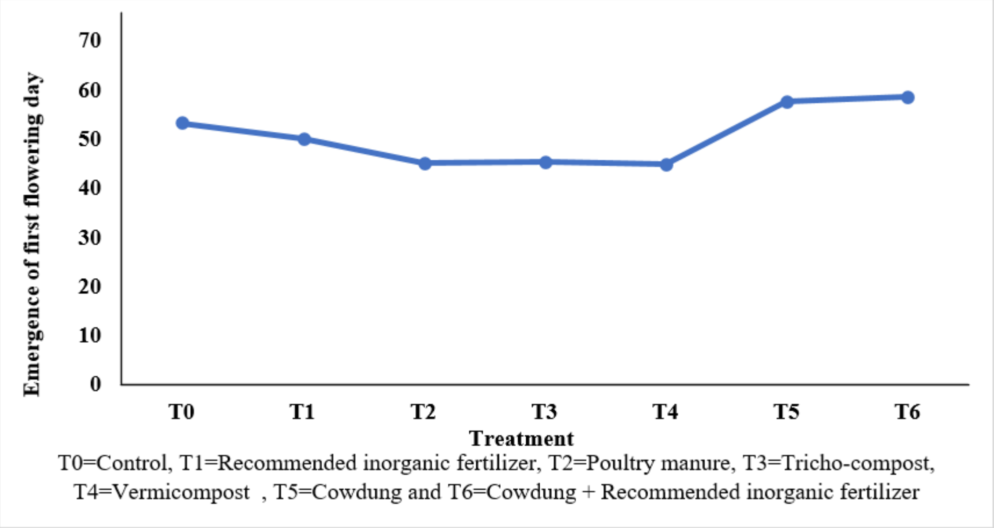

Figure 3: Effect of Different Organic and Inorganic Fertilizers on Emergence of First Flowering Day.

3.5 Number of Fruits Per Plant

The number of fruits per plant varied significantly with the use of different organic and inorganic fertilizers (Figure 4). The results indicated that the highest fruit count per plant (28.82) was observed in T_4, with T_3 and T_2 following. Conversely, the lowest count was noted in T_5, which was statistically comparable to T_0.

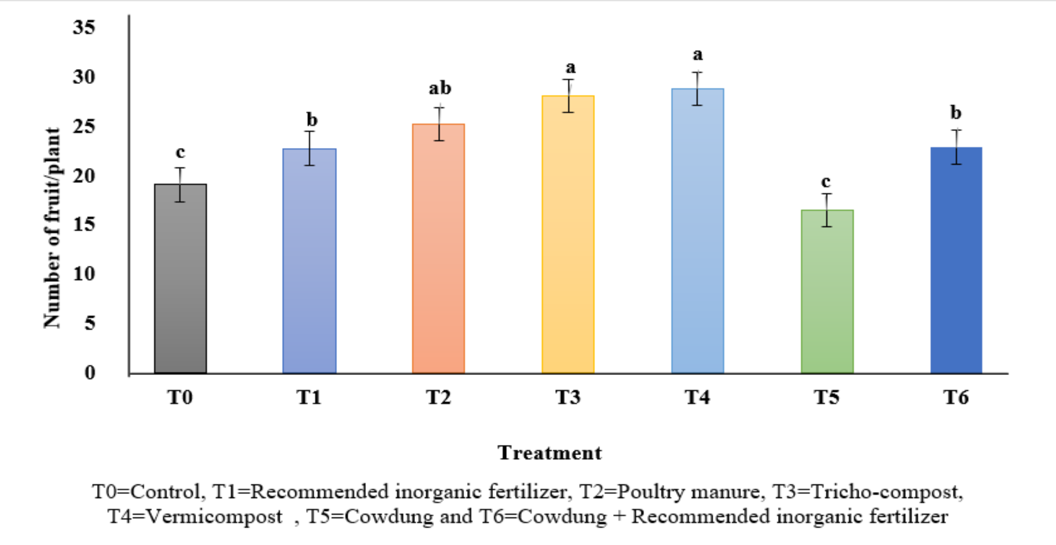

Figure 4: Effect of Different Organic and Inorganic Fertilizers on Number of Fruit/Plant

3.6 Fruit Length and Diameter

The variation in fertilizer levels significantly affected the growth of okra, particularly in terms of fruit length and diameter (Figure 5). Significant enhancement in the length and diameter of fruit was noted in Okra compared to the control (T_0) during the experimentation. Among the treatment combinations, the highest fruit length (11.68 cm) and diameter (1.82 cm) were recorded in T_6. Conversely, the lowest fruit length (8.47 cm) was observed in T_0, which was statistically similar to T_1, while the lowest diameter (1.62 cm) was found in T_1, which was statistically comparable to T_0.

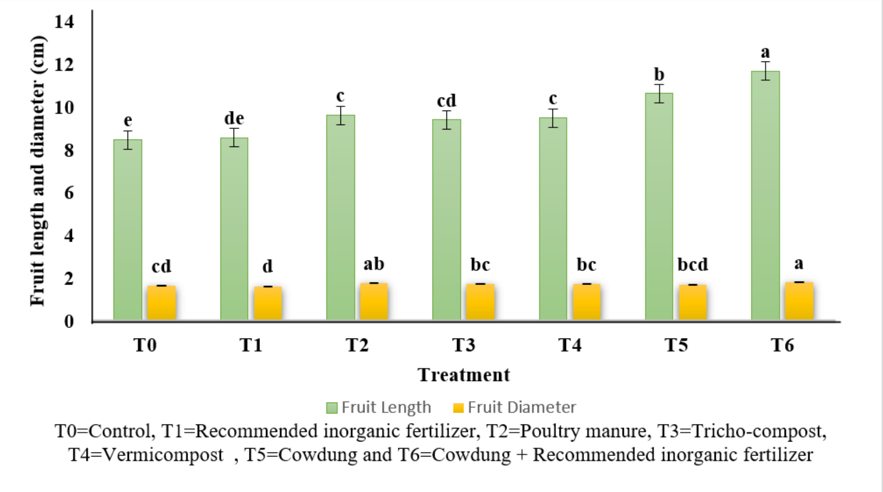

Figure 5: Effect of Different Organic and Inorganic Fertilizers on Fruit Length and Diameter

3.7 Individual Fruit Weight

There was a notable variation in individual fruit weight due to different applications of organic and inorganic fertilizers (Figure 6). The results showed that the highest individual fruit weight of 15.39 g was achieved with T_2 (Vermicompost) using 5 t ha^{-1} of poultry manure, while the lowest weight of 12.73 g was observed with T_0 (Figure 6).

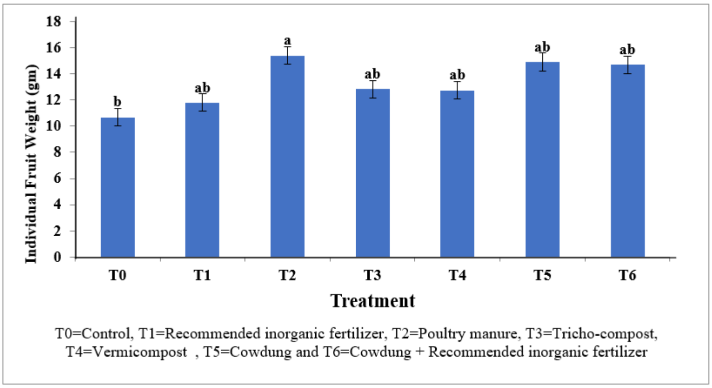

Figure 6: Effect of Different Organic and Inorganic Fertilizers on Single Fruit Weight (gm)

3.8 Total Yield

The total yield of okra varied significantly due to the variation of different fertilizers. Based on Figure 7, it showed that only application of poultry manure (T_2) gave the maximum yield (14.6 t ha^{-1}), and it showed statistically higher than other treatment combinations, while the minimum yield obtained from the control T_0 (7.65 t ha^{-1}) where no fertilizers was applied. However, the okra production based on poultry manure was statistically similar to Tricho-compost (T_3) and Vermicompost (T_4).

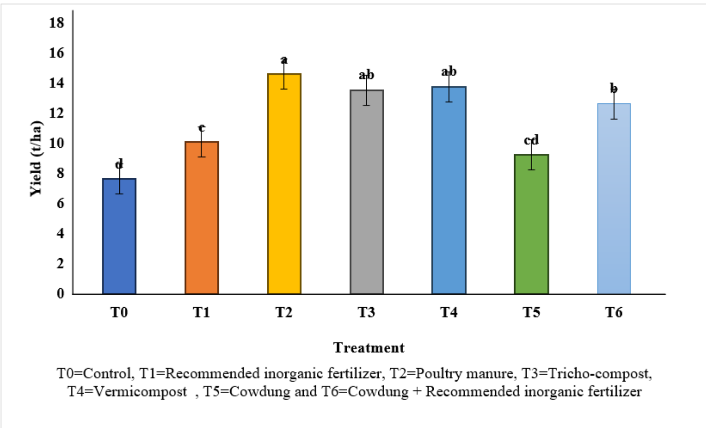

Figure 7: Effect of Different Organic and Inorganic Fertilizers on Total Yield ton/ha.

3.9 Discussion

Fertilizer, a crucial input in agriculture, plays an essential role in enriching crop production by enhancing fertility and elevating both the quantity and quality of yields. Organic amendments such as farmyard manure, poultry manure, and vermicompost are vital for improving soil fertility and productivity. They supply a significant amount of both macro and micronutrients, help prevent soil erosion, act as a binding agent for creating desirable soil aggregates, and increase soil porosity (Miah *et al.*, 2020).

The vital goals of organic agriculture are the optimization of the well-being and efficiency of interconnected ecosystems comprising soil microorganisms, flora, fauna, and human beings (Baliah *et al.*, 2017). Different studies have demonstrated that the application of animal manure and green manure has resulted in a significant enhancement in soil organic matter (OM), nitrogen (N), and phosphorus (P). This beneficial effect is likely due to the adequate supply of organic matter in the soil. The reduction in pH was also observed in the soil treated with organic amendments, compared to the control, can be attributed to the microbial breakdown of the added manures. This decomposition process may have released organic acids, which neutralized the alkalinity of the manures, leading to a decrease in soil pH below its original level. This agrees with the study of (Adekiya, 2017) reported that the application of Poultry manure, Vermicompost, and Trico-compost also reduced the pH level of the soil. Cow dung contains essential nutrients that increase soil fertility activities that promote root and vegetable growth. Poultry manure surpassed NPK in all the reproductive traits assessed, which is consistent with the findings of Kartina *et al.* (2019).

The poultry manure treatment showed the highest height at 80 days (Figure 1), measuring (99.2 cm), comparable to Vermicompost (97.13cm) and combined use of Cow dung and chemical fertilizer (93.08 cm). Okra grown on poultry manure exhibits improved plant height due to its easy absorption by the roots, indicating its potential for improved morphological growth. The outcome aligned with the research findings of (A & A, 2020) in Poultry manure, particularly organic manures, which has been found to significantly increase plant height in okra production, surpassing other sources of manure.

A notable increase in yield-related parameters such as the number of fruits, fruit diameter, and length was observed with both poultry manure and NPK fertilizer, as reported by Muhammad *et al.*, (2020). Their study found that applying 80 kg ha^{-1} of NPK fertilizer resulted in significantly greater fruit length, diameter, and weight, which aligns with our results. We used the lowest recommended dose of fertilizers since the experimental field was virgin and did not cultivate crops for many years. (Okee *et al.*, 2021) also reported, that the highest fruit diameter was found from treated with 5 t ha^{-1} of poultry manure. The measured growth components, precisely the number of leaves per plant, exhibited a noteworthy response that can be attributed to the pivotal role played by the application of organic fertilizers (Poultry manure, Vermicompost, and Tricho-compost) during the experimental trials. These essential nutrients play a crucial role in the overall growth and development of plants. This is corroborated by the research of Basfore *et al.*, (2018) and Aboyeji *et al.*, (2021), which showed that the use of organic fertilizers and organic mulch, under favorable environmental conditions, had a significant impact on okra growth. (Muhammad *et al.*, 2020; Coulibaly *et al.*, 2021) also reported similar results where the application of vermicompost and poultry manure contributed more to the increased number of leaves per plant in okra. However, in T_5 and T_6 treatment**,** the number of leaves was reported less since the most of the plants were affected by the virus, therefore, affected leaves were removed to avoid virus infestation. In this report, the number of days to the first flowering also came earlier in all organic matter compared to control, cow dung, and cow dung+inorganic fertilizers. Coulibaly *et al.*, (2021) reported that flowering came earlier in vermicompost which is in accordance with our findings.

Fertilizers serve as an indispensable input that are essential to improving crop productivity. Fertilizers play a pivotal role in enhancing not only the growth rate of crops but also the overall yield quantity and quality. Adekiya *et al.*, (2020) reported that the use of both organic and inorganic substances resulted in a significant enhancement in the growth parameters, including plant height and leaf area, as well as the yield indicators, such as okra pod weight and the number of pods plant^{-1}. Treatment with poultry manure had the highest value of okra pod followed by the NPK fertilizer. (Shahriazzaman *et al.*, 2014) and we observed similar trends in our current experiment. Poultry manure has been acknowledged as a highly effective organic fertilizer that enhances soil fertility by providing both key nutrients and organic matter. This not only boosts moisture and nutrient retention but may also lead to an increased production of pods. It was also observed that the soil textural classes was also changed to sandy loam to loam after application of organic matter which consequently improve the soil productively and thus influence the crop growth and production.

The highest yield was achieved with poultry manure, followed by vermicompost and Tricho-compost, with all three being statistically comparable (Figure 7). The increase in yield and yield-related traits may be due to the enhanced availability of plant nutrients, which improves the uptake of N, P, K, Ca, Mg, and others. Jamkatel *et. al.*, (2020) reported that organic manure positively impacts okra yield, with poultry manure yielding the highest results in their study. The results were consistent with earlier findings, where poultry manure applied as an organic source at 11.5 t ha^{-1} achieved the highest yield of 18 t ha^{-1} (Shahriazzaman *et. al.*, 2014). Additionally, Muhammad *et. al.*, (2020) reported that combining 8 t ha^{-1} of poultry manure with 80 kg ha^{-1} of NPK fertilizer resulted in the highest fruit weight. Coulibaly *et al.*, (2021) reported that, the combination of inorganic fertilizers and vermicompost had better agronomic characteristics compared to the control. That was because the treatments had a sufficient amount of essential nutrient which contributed better growth and maximum production. Adekiya *et al.*, (2020) observed similar trends in alignment with our finding that organic matter contributes comparatively higher yield.

4. Conclusion

The results indicated that, among the various organic and inorganic fertilizer treatments, okra is a high-demand crop with generally elevated nutrient needs. Okra benefits greatly from the use of poultry manure at a rate of 5 t ha^{-1}. This application significantly improves the plant's growth, yield characteristics, and overall yield. Production was 14.6 t ha^{-1}. Using poultry manure as an organic fertilizer supports sustainable agricultural practices by decreasing dependence on synthetic chemicals and reducing the environmental impact of farming. This approach not only benefits the farmer's income but also promotes long-term soil health and fertility. To evaluate and suggest the most effective dosages, it is essential to undertake multi-location trials encompassing diverse agro-climatic conditions since the results show variations across distinct ecosystems.

Author's contribution

The study conceptualization, methodology, writing, review, and editing were performed by M. R. Karim, Numerical analysis, writing, review, and editing by M A Sattar and M. M. Hoque. A. Rouf and S. Hossain conducted the experimentation, writing the initial draft.

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Conflict of interest

The authors affirm no potential conflict of interest concerning the publication of this work. Furthermore, the authors attest to addressing ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, with full diligence.

References

A, A., & A, P. (2020). Effect of Different Sources of Nutrient on Growth and Yield of Okra (Abelmoschus esculentus L. Monech). *International Journal of Environmental & Agriculture Research (IJOEAR)*, *6*(1), 45–50.

Aboyeji, C. M., Dahunsi, S. O., Olaniyan, D. O., Dunsin, O., Adekiya, A. O., & Olayanju, A. (2021). Performance and quality attributes of Okra (*Abelmoschus esculentus* (L.) Moench) fruits grown under soil applied Zn-fertilizer, green biomass, and poultry manure. *Scientific Reports*, *11*(1). doi:10.1038/s41598-021-87663-4

Adekiya, A. O. (2018). Legume Mulch Materials and Poultry Manure Affect Soil Properties, and Growth and Fruit Yield of Tomato. *Original Scientific Paper*, *83*(2), 161–167.

Adekiya, A. O., Ejue, W. S., Olayanju, A., Dunsin, O., Aboyeji, C. M., Aremu, C., … Akinpelu, O. (2020). Different organic manure sources and NPK fertilizer on soil chemical properties, growth, yield and quality of Okra. *Scientific Reports*, *10*(1). doi:10.1038/s41598-020-73291-x

Baliah, N. T., Lega Priyatharsini, S., & Priya, C. (2017). Effect of Organic Fertilizers on the Growth and Biochemical Characteristics of Okra (*Abelmoschus esculentus* (L.) Moench). In *International Journal of Science and Research (IJSR)*, 6(1), 678-682.

Bhandari, S., Pandey, S. R., Giri, K., Wagle, P., Bhattarai, S., & Neupane, R. B. (2019). Effects of different fertilizers on the growth and yield of Okra (*Abelmoschus esculentus L*.) in the summer season in Chitwan, Nepal. *Archives of Agriculture and Environmental Science*, *4*(4), 396–403. doi:10.26832/24566632.2019.040405

Basfore, S., Chatterjee, & Sikder, S. (2018). Impact of combination of different organic manures, bio-fertilizer, and organic mulches on growth and yield of okra. *Journal of Crop and Weed*, *14*(3), 57–60.

Coulibaly, S. S., Touré, M., Kouamé, A. E., Kambou, I. C., Soro, S. Y., Yéo, K. I., … Zoro, B. I. (2021). Vermicompost as an alternative to inorganic fertilizer to improve okra productivity in cô te d'Ivoire. *Open Journal of Soil Science*, *11*(01), 1–12. doi:10.4236/ojss.2021.111001

Dantas, T. L., Alonso Buriti, F. C., & Florentino, E. R. (2021). Okra (*Abelmoschus esculentus L*.) as a potential functional food source of mucilage and bioactive compounds with technological applications and health benefits. *Plants*, *10*(8), 1683. doi:10.3390/plants10081683

Domenico Prisa, & Alfonsino Testa. (2022). Use and evaluation of new organic fertilizers in the cultivation of *Abelmoschus esculenthus* (okra). *World Journal of Biology Pharmacy and Health Sciences*, *11*(3), 077–084. doi:10.30574/wjbphs.2022.11.3.0125

Jamkatel, D. P., Khatri, S., Bista, A., & Ghimire, A. (2020). Responses of organic and inorganic fertilizers on growth and yield of okra (*Abelmoschus esculentus* L. Moench CV. Arka Anamika). *Tropical Agroecosystems*, *1*(2), 64–66. doi:10.26480/taec.02.2020.64.66

Kartina, A. M., Utama, P., & Dimyati, I. (2019). Response growth and yield of OKRA (*Abelmoschus esculentus L*.) to giving dosage levels of chicken manure and variation of plants spacing. *IOP Conference Series: Earth and Environmental Science*, *383*(1). doi:10.1088/1755-1315/383/1/012028

Khandaker, M. M., Jusoh, N., Ralmi, N. H. A. A., & Ismail, S. Z. (2017). The Effect of Different Types of Organic Fertilizers on Growth and Yield of *Abelmoschus esculentus L*. Moench (Okra). *Bulgarian Journal of Agricultural Science*, *23*(1), 119–125.

Kota, A. K. R., Kerketta, A., Topno, S. E., Bahadur, V., & Tripathi, P. (2022). Effect of organic fertilizers on growth yield and quality of Okra (*Abelmoschus esculentus* L.) Kashi Lalima. *The Pharma Innovation Journal*, *11*(5), 2301–2301.

Meena, D. C., Meena, M. L., & Kumar, S. (2019). Influence of organic manures and biofertilizers on growth, yield, and quality of okra (*Abelmoschus esculentus L. Moench*). *Annals of Plant and Soil Research*, *21*(2), 130–134.

Miah, R., Methela, N. J., & Ruhi, R. A. (2020). Effect of integrated nutrient management on growth and yield of Okra. *Tropical Agrobiodiversity*, *1*(2), 72–76. doi:10.26480/trab.02.2020.72.76

Muhammad, M., Kutawa, A. B., & Adamu, M. (2020). Influence of NPK fertilizer and poultry manure on the growth of Okra (*Abelmoschus esculentus L. Moench*) in northern Sudan Savanna Region of Nigeria. *International Journal of Horticulture, Agriculture and Food Science*, *4*(6), 196–204. doi:10.22161/ijhaf.4.6.1

Okee, & Ikabi, J. (2020). Evaluation of the Effect of Organic Manure and Inorganic Fertilizer on the Growth and Yield of Okra (*Abelmoschus esculentus L, Moench*) in Lokoja, Kogi State, Nigeria. *International Journal of Agricultural Economics, Management and Development (IJAEMD)*, *8*(2).

Romdhane, M. H., Chahdoura, H., Barros, L., Dias, M. I., Corrêa, R. C., Morales, P., … Ferreira, I. C. (2020). Chemical composition, nutritional value, and biological evaluation of Tunisian okra pods (*Abelmoschus esculentus L. Moench*). *Molecules, 25*(20). doi:10.3390/molecules25204739

Shahriazzaman, M. C., Mazed, H. E. M. K., Pulok, M. A. I., Mehraj, H. & Jamal Uddin, A. F. M. (2014). Responses of Organic Manures on Growth and Yield of Okra (*Abelmoschus esculentus*). Journal of Science, Technology & Environment Informatics, 01(02), 60–67

Tarafder, S. K., Biswas, M., Alim, Md. A., & Mondal, A. B. (2023). The Effects of Organic Nutrient Sources on Yield and Shelf Life of Broccoli. *International Journal of Horticultural Science and Technology*, *10*(1), 87–96. doi:10.22059/ijhst.2022.339392.541

Uka, U., Chukwuka, K., & Iwuagwu, M. (2013). Relative effect of organic and inorganic fertilizers on the growth of okra [*Abelmoschus esculentus* (L.) Moench]. *Journal of Agricultural Sciences*, *Belgrade*, *58*(3), 159–166. doi:10.2298/jas1303159u

Unagwu, B. O., &Ayogu, R. U. (2022). Animal manure application effects on soil properties and okra (*Abelmoschus esculentus* L) growth and yield performance. *International Journal of Recycling of Organic Waste in Agriculture*, *11*(3), 333–342. doi:10.30486/IJROWA.2022.1910512.1137

Vikas, V., Sharma, J. P., Dhotra, B., Sharma, A., & Verma, D. (2020). Application of organic manures and their influence on okra growth parameters. *Journal of Pharmacognosy and Phytochemistry*, *9*(1), 999–1005.