



**COMPARATIVE INFLUENCE OF LIVESTOCK MANURES ON
SOIL FERTILITY AND OKRA (*Abelmoschus esculentus* L. Moench) GROWTH IN
CONTROLLED POT CONDITIONS**

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ABSTRACT

The study assessed the comparative effects of livestock manures on soil fertility and growth performance of okra. The treatments consisted of four livestock manures (cow, goat, pig, and poultry manures) and a control. The experiment was laid out in a completely randomized design (CRD) three replications. Manures were applied uniformly at a rate of 10 tons per hectare. Data were collected on various growth and yield attributes to assess the impact of the manures on plant development. The results indicated significant improvements in soil nutrient levels and okra performance with the use of organic amendments ($P < 0.05$). Poultry manure demonstrated the highest effectiveness among the different treatments applied. This highlights the potential of poultry manure as a valuable addition to enhance both soil quality and crop yields. Poultry manure significantly enhanced nitrogen (0.42%), potassium (2.50 cmol/kg), calcium (22.27 cmol/kg), and magnesium (10.13 cmol/kg) concentrations, as well as soil pH (6.39) better than the other manure used. Okra plants treated with poultry manure produced the tallest plants (57.93 cm), thicker stems (14.39 cm), higher leaf number (17.33), pod number (10.66), and fresh pod weight (38.95 g). These findings demonstrate the efficacy of poultry manure in improving soil fertility and okra yield, highlighting its potential as a sustainable nutrient source in tropical vegetable production systems.

Keywords: Nutrient, Organic, Amendments, Soil, Fertility, Yield.

INTRODUCTION

Okra is an important vegetable crop that is often valued for its edible pods and high nutritional content, particularly vitamins A and C and dietary fiber (Wahyuni and Trianisa, 2024). It contributes to increasing both nutrition levels and income for households across Africa. (Singh & Nigam, 2023). Okra cultivation plays a vital role in various agricultural systems, however, it faces challenges which include inadequate soil fertility. This is experienced majorly in sub-Saharan Africa, where practices such as continuous cropping contribute to the gradual depletion of essential soil nutrients. (Canellas *et al.*, 2022). This soil degradation leads to low productivity and food insecurity, necessitating immediate interventions to enhance soil health and improve agricultural yield (Vanlauwe *et al.*, 2015).

The use of organic fertilizers, particularly livestock manures, is increasingly recognized as a sustainable alternative to synthetic fertilizers, addressing various agricultural challenges (Almeida *et al.*, 2019). Animal manure (AM) serves as a sustainable nutrient source, supplying phosphorus, calcium, magnesium, and potassium, while also enhancing soil organic matter, microbial activity, and nutrient dynamics, thus addressing environmental quality standards and reducing reliance on mineral fertilizers (Almeida *et al.*, 2019). According to Badagliacca *et al.*, (2024), farmyard manure, as a type of organic fertilizer, provides vital nutrients for plant growth, improves the configuration of soil, increases its capacity to retain moisture, and promotes the activity of beneficial microorganisms., contributing to increased soil fertility and agricultural sustainability while supporting the transition towards environmentally sustainable practices in agriculture. Organic manures, such as farmyard and poultry manure, enhance soil structure, increase water retention, and improve microbial activity, while also supplying essential nutrients, thereby supporting sustainable crop production in maize-based cropping systems (Abid *et al.*, 2020).



Among these organic sources, Poultry manure is highly valued in agriculture for its rich nutrient content and rapid mineralization, making it an effective organic fertilizer, it contains significant levels of nitrogen, potassium and phosphorus which are important for plant growth (Magdy, 2017). However, its use also poses environmental challenges if not managed properly. Manure from ruminants like cows and goats decomposes more slowly due to higher fiber content, providing a gradual nutrient release (Zhu, 2019). Pig manure offers a middle ground in terms of nutrient content and decomposition rate but is less commonly utilized (Kacprzak *et al.*, 2022).

Despite the differences in manure characteristics, there remains a significant gap in comparative studies that assess the agronomic effectiveness of various livestock manures on the growth and yield of okra. Most of the research conducted to date has taken place in field settings, where factors such as fluctuating rainfall and diverse soil properties may obscure the true impacts of the treatments applied. This study intends to systematically assess the effects of cow, goat, pig, and poultry manures on soil fertility parameters and their influence on the growth and yield of okra, through controlled pot experiments.

MATERIALS AND METHODS

EXPERIMENTAL LOCATION AND SOIL PROPERTIES

The study was conducted at the Teaching and Research Farm, Federal University of Technology, Akure, Nigeria (7°15'N, 5°12'E). Topsoil samples were collected from a depth of 0 to 20 cm, then air-dried and passed through a sieve to eliminate any debris. The preliminary soil analysis indicated a pH level of 5.21, alongside a notably low nutrient content (Table 1).

Table 1: Baseline Physical and Chemical Characteristics of the Soil

| Parameter | pH | P (mg/kg) | K (cmol/kg) | Ca (cmol/kg) | Mg (cmol/kg) | N (%) |
|-----------|------|-----------|-------------|--------------|--------------|-------|
| Value | 5.21 | 4.18 | 1.19 | 4.59 | 2.47 | 0.18 |

TREATMENTS AND EXPERIMENTAL DESIGN

The treatments consisted of 4 livestock manure (cow, goat, pig, poultry) and a control. Each type of manure was carefully air-dried and then applied at a rate equivalent to 10 tons per hectare for each pot used in the experiment. The experiment was laid out in a completely randomized design (CRD) replicated three times.

CROP ESTABLISHMENT AND MAINTENANCE

Two okra seeds (var. NHAe-47-4) were sown per pot and thinned to one seedling after germination. Regular irrigation and weeding were maintained. No additional fertilization was applied during the experiment.

DATA COLLECTION

Data on plant height, stem girth, and number of leaves were recorded at 2, 4, and 6 WAP. At 8 WAP, pod number, length, girth, and fresh weight were measured. Soil samples were collected after harvest for chemical analysis.

STATISTICAL ANALYSIS

Data collected were subjected to analysis of variance (ANOVA) and treatment means were separated using Duncan's Multiple Range Test at $P < 0.05$.

RESULTS AND DISCUSSION

SOIL FERTILITY

Post-harvest soil analysis revealed a significant improvement in soil chemical properties across the treatments. Poultry manure (T5B2) led to the highest increase in nitrogen (0.42%), potassium (2.50 cmol/kg), calcium (22.27 cmol/kg), magnesium (10.13 cmol/kg), and pH (6.39), indicating enhanced soil fertility compared to other treatments (Table 2).

These findings indicate that poultry manure has a greater potential for nutrient release and buffering capacity compared to other organic inputs.



The observed increase in pH is of advantage for the acidic soils of Southwest Nigeria, where okra grows best in slightly acidic to neutral conditions. This outcome is consistent with the research conducted by Ojo *et al.* (2015), which demonstrated that the application of 2 kg of poultry manure dissolved in 100 liters of water led to enhancements in the chemical properties of the soil. It positively influenced levels of nitrogen, potassium, calcium, magnesium, and also improved the pH balance. The pH increased to 6.39, benefiting okra cultivation in these acidic soils. A study by Odulate *et al.* (2024) confirms that poultry manure significantly enhances soil chemical properties, with increases in nitrogen (0.42%), potassium (2.50 cmol/kg), calcium (22.27 cmol/kg), magnesium (10.13 cmol/kg), and pH (6.39). This suggests that poultry manure has a higher nutrient release potential and buffering capacity than cow manure. Poultry manure has proven to be an effective amendment for enhancing soil fertility and increasing crop yields. Its rapid mineralization and well-balanced nutrients contribute to enriching the soil, making it a valuable resource for farmers looking to boost productivity sustainably. This natural fertilizer not only addresses nutrient deficiencies but also promotes healthier plant growth, showcasing its importance in agricultural practices. Its effectiveness can be attributed to a lower carbon-to-nitrogen (C: N) ratio, higher microbial activity, and rapid decomposition.

Table 2: Post-Harvest Soil Chemical Properties Following Livestock Manure Application

| Treatment | N (%) | P (mg/kg) | K (cmol/kg) | Ca (cmol/kg) | Mg (cmol/kg) | Ph |
|--------------|--------------------------|---------------------------|--------------------------|---------------------------|---------------------------|--------------------------|
| T1 (Cow) | 0.38 ± 0.03 ^b | 5.28 ± 0.12 ^{ab} | 1.30 ± 0.10 ^b | 11.60 ± 0.90 ^b | 8.30 ± 0.80 ^b | 5.48 ± 0.10 ^b |
| T2 (Goat) | 0.22 ± 0.02 ^c | 4.27 ± 0.10 ^b | 2.18 ± 0.18 ^a | 5.47 ± 0.40 ^c | 2.73 ± 0.25 ^c | 5.44 ± 0.08 ^b |
| T3 (Pig) | 0.13 ± 0.01 ^d | 4.14 ± 0.09 ^b | 1.16 ± 0.09 ^b | 4.41 ± 0.35 ^c | 2.30 ± 0.20 ^c | 5.25 ± 0.07 ^b |
| T5 (Poultry) | 0.42 ± 0.04 ^a | 5.36 ± 0.13 ^a | 2.50 ± 0.20 ^a | 22.27 ± 1.20 ^a | 10.13 ± 1.00 ^a | 6.39 ± 0.15 ^a |

Note: Values are presented as mean ± standard error (n = 3). Means within a column followed by the same letter(s) are not significantly different at $p \leq 0.05$ according to Duncan's Multiple Range Test (DMRT). T1 = Cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Control (no manure), T5 = Poultry manure.

VEGETATIVE GROWTH PERFORMANCE

The result as presented in Table 3 revealed that, application of organic manures significantly influenced the vegetative growth of okra. Across all growth stages (2, 4, 6, and 8 WAP), poultry manure (T5) consistently produced better results in plant height, stem girth, and number of leaves.

The use of organic fertilizers significantly influenced the growth characteristics of okra across all measuring intervals (Tables 3-5). At 2 weeks after planting (WAP), poultry manure (T5) significantly increased plant height (12.61 cm), stem girth (5.24 cm), and number of leaves (11.83), performing better than all other treatments. Similar trends were observed at 4 and 6 WAP, where T5 recorded the highest values in all vegetative growth parameters, indicating sustained nutrient release and uptake. At 6 WAP, plants under poultry manure reached a height of 49.50cm and developed a stem girth of 14.26 cm with 17.17 leaves, all significantly higher than other treatments. T3 exhibited the lowest performance, which may be due to slower decomposition or lower nutrient content of the applied manure.

These results align with reports by Karim *et al.* (2024), which emphasized that poultry manure enhances the vegetative parameters of okra, achieving the highest plant height of 99.2 cm and other growth metrics. However, Tricho-compost showed the lowest performance, likely due to slower decomposition and lower nutrient content. Olamide *et al.* (2012) reported that poultry manure significantly boosted okra's vegetative growth, with an initial height of 12.61 cm, a stem girth of 5.24 cm, and 11.83 leaves at 2 WAP. By 6 WAP, the plants reached 49.50 cm in height, 14.26 cm in girth, and 17.17 leaves, outperforming all other treatments. This improved growth is attributed to the sustained nutrient release and superior nutrient content of poultry manure compared to other organic options.

Table 3: Effects of Organic Manures on Okra Growth at 2 WAP (\pm SE)

| Treatment | Plant Height (cm) | Stem Girth (cm) | Number of Leaves |
|--------------|-------------------------------|-------------------------------|--------------------------------|
| T1 (Cow) | 10.76 \pm 0.38 ^a | 3.26 \pm 0.12 ^b | 10.66 \pm 0.45 ^b |
| T2 (Goat) | 11.46 \pm 0.40 ^a | 3.45 \pm 0.15 ^b | 9.50 \pm 0.35 ^b |
| T3 (Pig) | 8.51 \pm 0.32 ^b | 3.87 \pm 0.22 ^b | 9.00 \pm 0.50 ^{ab} |
| T4 (Control) | 10.54 \pm 0.41 ^a | 4.12 \pm 0.25 ^{ab} | 10.66 \pm 0.47 ^{ab} |
| T5 (Poultry) | 12.61 \pm 0.37 ^a | 5.24 \pm 0.30 ^a | 11.83 \pm 0.42 ^a |

Note: Values are presented as mean \pm standard error (n = 3). Means within a column followed by the same letter(s) are not significantly different at $p \leq 0.05$ according to Duncan's Multiple Range Test (DMRT). T1 = Cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Control (no manure), T5 = Poultry manure.

Table 4: Effects of Organic Manures on Okra Growth at 4 WAP (\pm SE)

| Treatment | Plant Height (cm) | Stem Girth (cm) | Number of Leaves |
|--------------|-------------------------------|------------------------------|-------------------------------|
| T1 (Cow) | 31.69 \pm 1.2 ^{ab} | 8.45 \pm 0.5 ^{ab} | 15.16 \pm 0.6 ^{ab} |
| T2 (Goat) | 32.54 \pm 1.4 ^{ab} | 11.10 \pm 0.6 ^a | 15.33 \pm 0.7 ^{ab} |
| T3 (Pig) | 21.38 \pm 1.0 ^b | 2.71 \pm 0.3 ^b | 12.83 \pm 0.5 ^b |
| T4 (Control) | 30.86 \pm 1.1 ^{ab} | 4.06 \pm 0.4 ^b | 14.67 \pm 0.5 ^{ab} |
| T5 (Poultry) | 37.59 \pm 1.3 ^a | 12.42 \pm 0.7 ^a | 17.00 \pm 0.6 ^a |

Note: Values are presented as mean \pm standard error (n = 3). Means within a column followed by the same letter(s) are not significantly different at $p \leq 0.05$ according to Duncan's Multiple Range Test (DMRT). T1 = Cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Control (no manure), T5 = Poultry manure.

Table 5: Effects of Organic Manures on Okra Growth at 6 WAP (\pm SE)

| Treatment | Plant Height (cm) | Stem Girth (cm) | Number of Leaves |
|--------------|------------------------------|-------------------------------|-------------------------------|
| T1 (Cow) | 36.32 \pm 1.3 ^b | 10.52 \pm 0.6 ^{bc} | 15.16 \pm 0.7 ^{ab} |
| T2 (Goat) | 38.68 \pm 1.4 ^b | 11.68 \pm 0.7 ^b | 16.33 \pm 0.8 ^{ab} |
| T3 (Pig) | 30.63 \pm 1.0 ^b | 9.48 \pm 0.5 ^c | 13.33 \pm 0.6 ^b |
| T4 (Control) | 36.25 \pm 1.2 ^b | 10.21 \pm 0.6 ^{bc} | 14.00 \pm 0.6 ^b |
| T5 (Poultry) | 49.50 \pm 1.6 ^a | 14.26 \pm 0.8 ^a | 17.17 \pm 0.7 ^a |

Note: Values are presented as mean \pm standard error (n = 3). Means within a column followed by the same letter(s) are not significantly different at $p \leq 0.05$ according to Duncan's Multiple Range Test (DMRT). T1 = Cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Control (no manure), T5 = Poultry manure.

EFFECTS OF MANURES ON YIELD PERFORMANCE OF OKRA

Yield attributes including pod number, pod length, pod girth, and fresh pod weight were highest under poultry manure (T5). This treatment significantly outperformed others, suggesting its superior influence on reproductive development and productivity.

Yield attributes measured at 8 WAP revealed that poultry manure significantly improved all reproductive parameters (Table 6). Plants that received treatment with poultry manure (T5) exhibited remarkable growth characteristics. These plants reached an average height of 57.93 cm, produced an average of 10.66 fruits per plant, and had a pod length of 5.73 cm. The pod girth measured 27.44 cm, while the fresh weight of the pods averaged 38.95g. The results indicate the positive impact of poultry manure on plant development and productivity. The values we observed were substantially greater compared to what was noted for other treatments. T3 yielded the least results among the treatments. The higher pod weight under T5 suggests improved sink strength and assimilate partitioning, the observed improvements may stem from enhanced root growth and greater efficiency in nutrient absorption.

This is consistent with the research conducted by Owioye *et al.* (2024), which indicated that plants receiving 2.0 kg of poultry manure demonstrated the best reproductive outcomes. These included a plant height of 57.93 cm, an average of 10.66 fruits per plant, a pod length of 5.73 cm, a pod girth of 27.44 cm, and a fresh pod weight of 38.95g. The results are consistent with those of

Sodimu (2020), which also showed significant improvements in plant growth and yield following poultry manure treatment.

The highest recorded plant height was 57.93cm, and the average of 10.66 fruits per plant indicates a robust reproductive response. Pod characteristics were enhanced, with an average length of 5.73 cm and a girth of 27.44 cm, while the fresh pod weight reached a peak of 38.95g. These findings underscore the effectiveness of poultry manure in enhancing plant performance.

The improved reproductive performance observed with poultry manure suggests its ability to provide adequate nutrients throughout the crop cycle, particularly during the critical stages of flowering and pod formation.

Table 6: Effects of Manures on Okra Yield at 8 WAP

| Treatment | Plant Height (cm) | Stem Girth (cm) | No. of Fruits | Pod No. | Pod Length (cm) | Pod Girth (cm) | Fresh Pod Weight (g) |
|-------------|-------------------------|-------------------------|------------------------|-------------------------|------------------------|-------------------------|-------------------------|
| T1 (Cow) | 52.82±1.5 ^{bc} | 13.04±0.7 ^a | 16.66±0.8 ^a | 7.76 ± 0.4 ^a | 3.67± 0.3 ^a | 10.77±0.6 ^a | 23.09±1.0 ^{bc} |
| T2 (Goat) | 53.56±1.5 ^a | 13.33±0.8 ^a | 16.83±0.9 ^a | 8.00 ± 0.5 ^a | 4.27± 0.4 ^a | 14.23±0.7 ^a | 23.08±1.1 ^{bc} |
| T3 (Pig) | 39.91± 1.2 ^b | 9.47 ± 0.6 ^b | 12.66±0.7 ^b | 5.00 ± 0.3 ^a | 2.59± 0.3 ^a | 8.42 ± 0.5 ^a | 8.44 ± 0.8 ^b |
| T4 (Contr) | 48.79±1.4 ^{bc} | 12.96±0.7 ^a | 14.96±0.9 ^b | 7.00 ± 0.4 ^a | 2.76± 0.3 ^a | 18.86±0.6 ^a | 13.19± 0.9 ^b |
| T5 (Poultr) | 57.93± 1.7 ^a | 14.39±0.9 ^a | 17.33±0.9 ^a | 10.66±0.5 ^a | 5.73±0.4 ^a | 27.44±1.1 ^a | 38.95± 1.4 ^a |

Note: Values are presented as mean ± standard error (n = 3). Means within a column followed by the same letter(s) are not significantly different at $p \leq 0.05$ according to Duncan's Multiple Range Test (DMRT). T1 = Cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Control (no manure), T5 = Poultry manure.

CONCLUSION AND RECOMMENDATION

This research emphasizes the advantages of utilizing poultry manure to improve soil fertility and promote the growth of okra in controlled pot environments. The findings suggest that incorporating poultry waste not only enriches the soil but also contributes positively to the overall development of okra plants. Our findings show that among the different types of manure tested, poultry manure stands out for its positive impact on key soil nutrients, particularly nitrogen, potassium, calcium, magnesium, and pH levels, all of which are essential for sustainable crop production.

Okra plants that received poultry manure demonstrated better overall health and productivity. These plants exhibited greater height, thicker stems, more leaves, increased fruit numbers, larger pod sizes, and heavier fresh pods. The consistent effectiveness of poultry manure across various growth and yield measures suggests its potential as a valuable organic amendment for sustainable vegetable farming.

Given its rapid decomposition and well-balanced nutrient profile, poultry manure is suited for enriching nutrient-poor tropical soils. In comparison, other types of manure, such as cow, goat, and pig manure, while still beneficial, did not perform as well for okra cultivation. This is likely due to their slower breakdown and lower nutrient availability.

These results highlight the importance of including poultry manure into soil fertility management practices, especially in areas where environmentally friendly farming methods are emphasized. It is essential to investigate the long-term effects of poultry manure on soil health. We should focus on identifying optimal application rates across various seasons and explore the potential of integrating it with other organic or biological amendments. This approach could enhance nutrient availability and improve the resilience of our agroecosystems.

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