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Research Article

Effect of Poultry Manure and NPK (15: 15: 15) Fertilizer on The Growth and Yield of Tomato (*Lycopersicon esculentum* L.)

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Abstract

Agricultural practices such as the application of organic and inorganic fertilizers play a crucial role in enhancing crop productivity. The impact of poultry manure and NPK (15:15:15) fertilizer on the growth and yield of tomato (Lycopersicon esculentum L.) was examined in Owo, South Western Nigeria. This study employed a randomized complete block design (RCBD) with three treatments (No manure as control, NPK (15:15:15) at 200 kg/ha, and poultry manure at 2.5 t/ha) allocated randomly across plots using balloting methods, each replicated thrice. Seedlings were spaced at 30 x 60 cm, resulting in a total of 108 stands across nine plots. Various parameters including plant height, stem girth, number of leaves, number of flowers, number of fruits, and fruit weight were assessed through statistical analysis. Results showed that poultry manure significantly enhanced vegetative growth parameters such as plant height, leaf number, and leaf area compared to the control. At 2, 4, and 6 weeks after transplanting (WAT), poultry manure consistently outperformed NPK in terms of plant height and leaf area. However, NPK showed a superior number of flowers and fruit yield, highlighting its rapid nutrient release and immediate availability. Despite NPK's effectiveness, the overall yield attributes of poultry manure were comparable, suggesting its potential as a sustainable alternative due to its soil-enriching properties and long-term benefits. This study underscores the importance of integrating organic and inorganic fertilizers to optimize tomato yield and soil health, advocating for further research into the economic and long-term impacts of organic fertilization in tropical agriculture.

Keywords

Tomato, *Lycopersicon esculentum* L., Poultry Manure, NPK Fertilizer, Randomized Complete Block Design

1. Introduction

Tomatoes (*Lycopersicon esculentum* L.) belong to the nightshade family (Solanaceae) and are esteemed for their juicy, nutrient-rich berries. Cultivated from the wild tomato variety *Lycopersicum esculentum* var. caraciform, tomatoes hold a significant dietary and cultural importance worldwide, particularly in Nigeria, where they are a staple ingredient in various culinary dishes. Rich in vitamins A and C, as well as minerals like calcium, phosphorus, and iron, tomatoes offer not only nutritional benefits but also potential medicinal properties, including cancer prevention and heart disease management [1, 2].

Despite their nutritional value, tomato yield variability

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persists, often attributed to factors such as soil fertility fluctuations. In efforts to bolster food security and achieve agricultural development goals, optimizing soil fertility becomes imperative. Historically, the application of inorganic fertilizers was advocated to mitigate the inherent soil fertility challenges in tropical regions [3]. However, concerns regarding cost, environmental impact, and diminishing crop productivity have underscored the need for alternative fertilization strategies [4].

Poultry manure emerges as a valuable agricultural resource, comprising a blend of organic and inorganic compounds essential for plant growth. Rich in nitrogen, phosphorus, and potassium, poultry manure not only provides essential nutrients but also improves soil structure, water retention, and microbial activity [5]. Despite its benefits, the widespread adoption of poultry manure is hindered by logistical challenges such as transportation, storage, and odor management [6].

Conversely, inorganic fertilizers like NPK (15:15:15) offer rapid nutrient uptake and precise nutrient composition but may pose environmental risks if overused. The indiscriminate application of inorganic fertilizers can lead to soil acidification, nutrient imbalances, and groundwater pollution, threatening long-term soil fertility and ecosystem health [7].

This study investigated the efficacy of poultry manure and NPK (15:15:15) fertilizer on tomato growth and yield in Owo, South Western Nigeria. Through a randomized complete block design (RCBD), the experiment evaluated the impact of these fertilization methods on various growth parameters, aiming to inform sustainable agricultural practices conducive to enhanced tomato production in the region. By elucidating the advantages and limitations of both organic and inorganic fertilizers, this research contributes to the ongoing discourse on soil fertility management and agricultural sustainability in tropical regions [8].

2. Materials and Methods

2.1. Site Description

The field experiment was conducted at the Teaching and Research Farm of Rufus Giwa Polytechnic Owo, Ondo State, Nigeria. Situated within the coordinates 7 °1' 20" N, 5 °E, the study area falls within the rain-fed agro-ecological zone of southwestern Nigeria. Characterized by a bimodal monthly rainfall distribution pattern spanning from April to July with a peak in July, and from September to November with a notable peak in September, the annual rainfall ranges from 1200 mm to 2000 mm. The temperature typically varies between an average maximum of 29 ℃ and minimum of 15 ℃, maintaining consistency throughout the year. Relative humidity fluctuates from 60% in the dry season to 80% in the rainy season. The experimental site, previously cultivated with various arable crops such as yam, maize, cassava, groundnut, sorghum, melon, and cucumber, was manually cleared before experimentation, with prevalent weeds including siam weeds (*Chromolena odorata*) and water leaf (*Talinum triangulare*).

2.2. Land Preparation

The field was manually cleared, debris was removed, and nine (9) seed beds were prepared using hoe and cutlass. Each seed bed measured 1.5 m x 1.5 m in length and breadth, with a discard area and pathway of 0.5 m each, resulting in a total experimental plot area of 9 m x 9 m.

2.3. Experimental Design

The experimental field was arranged in a randomized complete block design (RCBD) comprising three treatments: poultry manure, NPK (15:15:15) fertilizer at 200 kg/ha, and a control, each replicated three (3) times.

2.4. Nursery Operation / Transplanting

Seeds were sown by broadcasting on a raised nursery bed and nurtured for three (3) weeks under intensive care.

2.5. Application of Soil Amendments

Poultry manure was incorporated into the soil two weeks before sowing, while NPK (15:15:15) fertilizer was applied two weeks after sowing. No treatment was applied to the control, which was watered heavily twice a day to facilitate the mixing of manure with the soil.

2.6. Transplanting

Transplanting was carried out four (4) weeks after sowing, with plants spaced at 30 cm x 60 cm and firmly placed with the ball of earth to prevent displacement by wind.

2.7. Weeding

The first weeding was performed with a hoe and cutlass two weeks after planting, followed by a second weeding at the fifth week and a final weeding at the eighth week after planting.

2.8. Data Collection and Statistical Analysis

Five stands were tagged in each plot for data collection. Growth parameters such as plant height, leaf area, number of branches, and stem girth were recorded, while yield components including number of flowers, number of fruits, and fruit weight were documented. Data collected were subjected to analysis of variance (ANOVA), and mean values were compared using Tukey's test at a significance level of 5%.

3. Results and Discussion

3.1. Results

Table 1 presents the mean values of tomato plant height across different weeks after transplanting (WAT). At 2 WAT, plant height under control was 17.56, while poultry manure and NPK recorded 22.51 and 21.59, respectively. By 4 WAT, NPK showed the highest plant height (41.79), followed by poultry manure (39.65), with control exhibiting the least (32.56). Significant differences were observed between control and fertilized treatments ($p<0.05$). At 6 WAT, poultry manure demonstrated the highest plant height (76.17), followed by NPK (67.72), with control trailing (60.27). Similarly, at 50% flowering stage, poultry manure exhibited the highest plant height (92.71), followed by NPK (79.63), while control showed the lowest (75.36).

Table 2 details the number of leaves of tomato plants at different stages. At 2 WAT, control had 5.80 leaves, while poultry manure and NPK recorded 8.87 and 7.53, respectively. By 4 WAT, poultry manure showed the highest leaf count (10.73), followed closely by NPK (10.67), with control exhibiting the lowest (8.93). Significant differences were observed between control and fertilized treatments ($p<0.05$). This trend continued at 6 WAT and the 50% flowering stage, with poultry manure consistently outperforming both NPK and control.

Table 3 highlights the leaf area of tomato plants throughout the study. At 2 WAT, poultry manure displayed the highest leaf area (132.73), followed by NPK (118.23), with control recording the lowest (109.95). Significant differences were observed between treatments ($p<0.05$). Similar trends were observed at subsequent stages, with poultry manure consistently exhibiting larger leaf areas compared to NPK and control.

Table 4 illustrates the stem girth of tomato plants across different stages. At 2 WAT, no significant differences were observed between treatments. However, by 4 WAT, poultry manure and NPK showed significantly larger stem girth compared to control ($p<0.05$). This trend continued at 6 WAT and the flowering stage, with poultry manure consistently outperforming both NPK and control.

Table 5 presents the number of flowers, fruits, and fruit weight of tomato plants. NPK exhibited the highest number of flowers (7.63), followed by poultry manure (4.60), with control showing the lowest (1.87). Significant differences were observed between poultry manure and NPK ($p<0.05$). Regarding fruit yield, NPK outperformed both poultry manure and control, with the highest number of fruits (39.60) and fruit weight (0.40). However, poultry manure showed comparable results, indicating its effectiveness in enhancing tomato yield.

3.2. Discussion

The application of poultry manure significantly promoted the vegetative growth of tomato plants, a finding consistent with previous studies such as Adediran *et al.* [9] on tomatoes and Aliyu [10] on pepper (Capsicum annum L.). This suggests that poultry manure, with its rich nutrient content, can effectively supply essential nutrients to plants, comparable to inorganic fertilizers like NPK (15:15:15). Altunaga [11] highlighted the mineral composition of poultry manure, indicating its potential to match the nutrient availability of inorganic fertilizers, thereby serving as a potent crop booster.

While poultry manure positively influenced tomato yield and yield attributes in this study, certain parameters such as the number of flowers and fruits showed significant influence from NPK (15:15:15). Although the effects were not significantly different from poultry manure, the rapid mineralization process of inorganic fertilizer, particularly nitrogen, may explain this phenomenon. Aliyu [10] noted the rapid release of nitrogen from NPK, crucial for various growth processes in plants, contributing to its impact on yield parameters.

Interestingly, despite the notable effects of NPK on certain yield parameters, there were no significant differences in overall yield and yield attributes compared to poultry manure. This underscores the agronomic benefits associated with organic manure, particularly poultry manure, including its environmental compatibility and soil-friendly nature. This aligns with previous research by Awodun *et al.* [12], Egwu [13], and Aini *et al.* [14], emphasizing the superiority of organic fertilizers in enhancing soil productivity and crop yield.

Moreover, the retention of a significant portion of nitrogen from poultry manure within the root zone provides a sustained nutrient supply, contrasting with the leaching tendencies of NPK from the root system, as noted by Bater *et al.* [15]. This further emphasizes the long-term benefits and soil health implications of utilizing organic manure in agricultural practices.

Overall, the findings highlight the efficacy of poultry manure as a sustainable alternative to NPK fertilizer for enhancing tomato growth and yield. Future research exploring the economic viability and long-term effects of organic fertilizers could provide valuable insights into optimizing fertilization strategies for sustainable agriculture.

Table 1. Effects of treatment on plant height (cm).

Treatments	Weeks After Planting			
	2	4	6	50 % flowering stage
Poultry manure	22.51a	39.65a	76.17a	92.71a
NPK	21.59a	41.79a	67.72a	79.63b
Control	17.56b	32.56a	60.27b	75.36bc

Means that do not share a letter in a column are not significantly different ($p<0.05$)

Table 2. Effects of treatment on number of leaves (cm).

Treatments	Weeks After Transplanting			
	2	4	6	50 % flowering stage
Poultry manure	8.87a	10.73a	30.92a	29.25a
NPK	7.53a	10.67a	25.92a	29.15a
Control	5.80a	8.93a	17.40a	20.20a

Means that do not share a letter in a column are not significantly different ($p<0.05$)

Table 3. Effects of treatment on leaf area (cm^2).

Treatments	Weeks After Transplanting			
	2	4	6	50 % flowering stage
Poultry manure	132.73a	145.13a	175.20a	193.20a
NPK	118.23a	145.85a	171.22a	190.51a
Control	109.95a	149.31a	158.45a	178.64a

Means that do not share a letter in a column are not significantly different ($p<0.05$)

Table 4. Effect of treatment on stem girth (cm).

Treatments	Weeks After Transplanting			
	2	4	6	50 % flowering stage
Poultry manure	1.76a	3.01a	4.11a	4.70a
NPK	1.77a	3.01a	4.55a	4.46a
Control	1.40a	2.41a	3.43a	3.93a

Means that do not share a letter in a column are not significantly different ($p<0.05$)

Table 5. Effect of treatments on Number of flowers (cm), Number of Fruits (cm) and weight of fruits (kg).

Treatments	Number of flowers	Number of fruits	Weight of fruits (kg)
Poultry manure	4.60a	22.50a	0.33a
NPK	7.63a	39.60a	0.40a
Control	1.87a	15.87a	0.10a

Means that do not share a letter in a column are not significantly different ($p<0.05$)

4. Conclusion

The analysis of the data in Table 1 shows that the plant height reached its maximum in week 4 under Treatment 1, with a measurement of 92.71 cm. This height was 41.79 cm higher than the height resulting from the control treatment. The application of poultry manure fertilizer alone was effective in promoting the height, yield, and leaf growth of the experimental tomato plants.

Additionally, the use of NPK 15:15:15 fertilizer proved to be slightly more effective than poultry manure in promoting the yield of the experimental tomato plants. However, the combined treatment of NPK 15:15:15 and poultry manure was the most effective in enhancing the yield of the tomato plants compared to any other treatment. These findings indicate that the yield of the experimental tomato plants responds differently to each of the various treatments. Therefore, I recommend further investigation into the effects of organic manure at different levels to optimize the growth and yield of tomatoes.

Abbreviations

NPK Nitrogen, Phosphorus and Potassium
WAT Week After Treatment

Author Contributions

Obabire Sadiq Ola is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

No conflict of interest.

References

[1] Ali, M. Y., Sina, A. A. I., Khandker, S. S., Kawser, M., Hossain, A., & Kabir, A. (2020). Nutritional and medicinal values of tomatoes. Journal of Nutrition and Food Sciences, 10(1), 1-5.

[2] Friedman, M. (2013). Anticarcinogenic, cardioprotective, and other health benefits of tomato compounds lycopene, α-tomatine, and tomatidine in pure form and in fresh and processed tomatoes. Journal of Agricultural and Food Chemistry, 61(40), 9534-9550.

[3] Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2016). Soil Fertility and Fertilizers (8th ed.). Pearson.

[4] Raza, A., Ashraf, F., Zou, X., Zhang, X., & Lv, Y. (2020). Impact of fertilizer management on soil health and crop productivity: A review. *\Agronomy, 10(12), 1862.

[5] Ghimire, R., Acharya, B. S., Bista, P., McDonald, L. M., & Poudel, D. D. (2022). Poultry manure as a sustainable organic fertilizer: Effect on soil properties and crop productivity. Agronomy Journal, 114(2), 1-15.

[6] Eghball, B., & Power, J. F. (2021). Phosphorus- and nitrogen-based manure and compost applications: Corn production and soil phosphorus. Soil Science Society of America Journal, 85(2), 547-556.

[7] Zhang, W., Tian, Y., Lu, Y., & Zhang, H. (2021). Environmental impacts of fertilization strategies in agriculture: A review. Environmental Science and Pollution Research, 28(8), 8750-8766.

[8] Olaniyi, J. O., Akanbi, W. B., Adejumo, T. A., & Akande, O. G. (2022). Growth, fruit yield and nutritional quality of tomato varieties. African Journal of Food Science, 16(3), 56-68.

[9] Adediran, J. A., Taiwo, L. B., & Sobulo, R. A. (2003). Organic wastes and their effect on tomato (Lycopersicum esculentus) yield. Africa Soils, 33, 99-116.

[10] Aliyu, L. (2000). The effect of organic and mineral fertilizer on growth, yield, and composition of pepper (Capsicum annum L). Journal of Biological, Agricultural and Horticultural Sciences, 18, 29-36.

[11] Altunaga, C. H. (2007). Study of the mineral composition of poultry manure by the systematic variant method. American-Eurasian Journal of Agriculture and Environmental Science, 1(2), 302-307.

[12] Awodun, M. A. (2007). Effect of poultry manure on the growth, yield, and nutrient content of fluted pumpkin (Telfaria accidentalis). Asian Journal of Agricultural Research, 1(2), 67-73.

[13] Egwu, M. O. (2005). The Fadama II Project and sustainable fibre and vegetable production in Nigeria. Ife Journal of Agriculture, 1, 134-149.

[14] Aini, Z., & Vimala, P. (2002, July 22-26). Research and development of organic crop production in Malaysia. Paper presented at the Expert Group Workshop on Preparation of Technical Guidelines on Organic Cultivation of Tropical and Subtropical Fruits, INTAN Bukit Kiara, Kuala Lumpur.

[15] Bater, M. L., & Earhart, D. R. (2009). Use of poultry litter on vegetables. Texas Cooperative Extension.