

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (*Allium Cepa*) in Damaturu, Yobe State, Nigeria

Abdullahi Bukar and Abbas Sada

Department of Agricultural Technology, The Federal Polytechnic Damaturu, Yobe State, Nigeria.

Email: saat@fedpodam.edu.ng

Abstract

A field experiment was conducted at the Teaching and Research Orchard Farm of the Federal Polytechnic, Damaturu, Yobe State, to compare the effects of inorganic fertilizer and different organic manure sources on the growth and yield indices of two onion (*Allium cepa* L.) varieties (Red and White). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Four treatments were evaluated: Inorganic fertilizer (NPK 15-15-15), Poultry manure (applied at 20175 kg/hectare), Cattle dung (applied at 20175 kg/hectare), and a Control (no amendment). Growth parameters (plant height, number of leaves per plant) and yield parameters (bulb diameter, total yield per plot) were collected and analyzed using SPSS. The results indicated that both organic and inorganic amendments significantly ($P < 0.05$) improved the growth and yield of both onion varieties compared to the control. Poultry manure recorded the highest mean total bulb yield (18.4 kg/plot for Red and 17.1 kg/plot for White), outperforming NPK fertilizer and cattle dung. This study demonstrates that poultry manure provides an environmentally sustainable and economically viable alternative to synthetic fertilizers for onion production in semi-arid tropical soils.

Keywords: *Allium cepa*, Poultry manure, Cattle dung, NPK fertilizer, Yield indices, Semi-arid.

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (Allium Cepa) in Damaturu, Yobe State, Nigeria

1. INTRODUCTION

Onion (*Allium cepa* L.) is a major vegetable and spice crop widely cultivated in the Northern part of Nigeria, playing a critical role in human nutrition, local economies, and traditional medicine (Kaka *et al.*, 2021). Ranking as the second most important vegetable in Nigeria after tomatoes, onions are consumed daily across virtually all households.

Despite its high economic value, onion production in tropical ecosystems faces serious constraints due to poor soil conditions resulting from continuous cultivation without adequate fallow periods (Jauro *et al.*, 2026). Historically, the excessive application of intensive synthetic fertilizers was advocated to rapidly maximize vegetable yields. However, the continuous use of inorganic fertilizers degrades soil physical and chemical structures, intensifies soil acidity, induces nutrient imbalances, and poses long-term hazards to human health and environmental safety (Pahalvi *et al.*, 2021). Furthermore, skyrocketing commercial fertilizer prices have made them unaffordable for resource-poor peasant farmers.

Consequently, there is a revived interest in renewable, eco-friendly organic amendments such as poultry manure and farmyard manure (FYM). Organic manure supplies vital macro- and micro-nutrients, stimulates beneficial microbial activity, alters soil pH, and substantially improves the moisture-holding capacity of fragile, semi-arid soils. While previous studies in rainforest regions have explored organic applications, there remains a critical gap in optimizing organic and inorganic combinations specifically for distinct onion cultivars under semi-arid conditions like Damaturu, Yobe State.

This study specifically examines the comparative effects of NPK 15-15-15, poultry manure, and cattle dung on the growth and yield indices of Red and White onion varieties under the semi-arid environmental conditions of Damaturu.

2. MATERIALS AND METHODS

2.1 Study Area

The field experiment was conducted at the Department of Agricultural Technology Orchard Farm, Federal Polytechnic, Damaturu, Yobe State, Nigeria. The site is geographically positioned between latitude 11°44'49.09" N, longitude 11°57'38.99" E, at an altitude of 371.87m above sea level, featuring a classic semi-arid climate.

2.2 Experimental Design and Treatments

The total experimental area of 266 m² was laid out in a Randomized Complete Block Design (RCBD) arranged in a factorial configuration with three replications. Each plot measured 3.0 m by 1.5m. Intra- and inter-row spacings were 15 and 30 cm, respectively. Plant population per plot was 100. Factor A comprised two onion varieties (Red Onion and White Onion). Factor B comprised four nutrient treatments:

- T_1 : Inorganic Fertilizer (NPK 15-15-15)
- T_2 : Poultry Manure (applied at a rate of 20175 kg/hectare)
- T_3 : Cattle Dung (applied at a rate of 20175 kg/hectare)
- T_4 : Control (No soil amendment applied)

2.3 Cultural Practices

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (Allium Cepa) in Damaturu, Yobe State, Nigeria

Land preparation involved clearing all existing vegetation debris using hoes, cutlasses, and rakes to eliminate potential early weed competitions. Mechanical ploughing was carried out using ox-driven plough to loosen the soil profile, maximize water percolation, and establish an optimal rhizosphere environment for soil microorganisms. Seedlings were nurtured on raised nursery beds and watered twice daily (early morning and late evening) using watering cans.

Healthy seedlings were transplanted onto the main field plots. Hand-pulling and hoe weeding were routinely executed to maintain clean plots. Insect pests were managed via strategic applications of cypermethrin using knapsack sprayers, while protective perimeter netting was installed along plot boundaries to suppress rodent entry. Organic manures were fully incorporated into designated plots at the rate of 20175 kg/hectare, followed by immediate irrigation to assist decomposition and soil integration. Harvesting took place manually by hand-pulling once 50% of the plant foliage showed signs of drying and lodging.

2.4 Data Collection

Data collections were executed bi-weekly from five randomly selected and tagged plants per plot. Growth parameters included Plant Height (cm) measured with a meter rule and Number of Leaves per Plant counted manually. Yield metrics recorded at harvest included Bulb Diameter (cm) measured using a mechanical divider calibrated against a standard ruler, and Total Yield per Plot (kg) assessed with a digital weighing balance.

2.5 Statistical Analysis

The generated dataset was subjected to a two-way Analysis of Variance (ANOVA) using the Statistical Package for the Social Sciences

(SPSS) software. Treatment means were compared and separated using Duncan's Multiple Range Test (DMRT) at a 5% significance level ($P \leq 0.05$).

3. RESULTS AND DISCUSSION

3.1 Growth Indices

The experimental results showed that nutrient treatments significantly ($P < 0.05$) influenced the vegetative characteristics of both onion varieties. Poultry manure (T_2) consistently produced the tallest plants and the highest leaf count across both varieties, closely followed by the NPK treatment (T_1).

The superior vegetative growth observed in poultry manure plots aligns with recent findings by Singh *et al.* (2023), who demonstrated that poultry manure maximizes photosynthetic capacity and physiological growth parameters in onions owing to its rapid mineralization rates and substantial content of vital macro- and micro-nutrients. The rapid availability of nitrogen from poultry manure accelerates structural protein and enzyme synthesis, directly manifesting as taller plant structures and higher leaf counts. This trend is further supported by Salamandane (2022), who established that the application of chicken manure drastically elevates soil organic matter and beneficial microbial biomass, creating an optimal rhizosphere environment that enhances nutrient uptake compared to unamended soils.

While the chemical NPK treatment (T_1) also demonstrated robust growth indices due to its immediate supply of readily available primary nutrients, it lacked the long-term structural and moisture-retention soil modifications offered by organic options, a factor critical for sustained vegetative growth in semi-arid soils. Recent frameworks by Oliveira *et al.* (2023) highlight that while synthetic NPK efficiently triggers

rapid early-stage vegetative expansion, organic amendments ensure a more balanced, prolonged nutrient release that keeps pace with the continuous growth demand of the onion crop. Conversely, the severely stunted growth parameters and lower leaf counts recorded in the

control plots (T_4) confirm that the baseline nutrient content of these fragile, semi-arid topsoils is highly deficient, validating the necessity of robust nutrient supplementation as corroborated by Al-Bayati (2023).

Table 1: Effects of Inorganic and Organic Soil Amendments on Growth Parameters of Onion Varieties (at 8 Weeks After Transplanting)

Variety	Treatment	Mean Plant Height (cm)	Mean Number of Leaves/Plant
Red Onion	T_1 : NPK 15-15-15	48.5 ^b	8.2 ^{ab}
	T_2 : Poultry Manure	53.2 ^a	9.6 ^a
	T_3 : Cattle Dung	44.1 ^c	7.4 ^{bc}
	T_4 : Control	32.4 ^d	5.1 ^d
White Onion	T_1 : NPK 15-15-15	46.1 ^b	7.9 ^b
	T_2 : Poultry Manure	50.8 ^a	9.1 ^a
	T_3 : Cattle Dung	42.3 ^c	7.0 ^c
	T_4 : Control	30.2 ^d	4.8 ^d

Means within the same column followed by different superscript letters are significantly different ($P \leq 0.05$) according to Duncan's Multiple Range Test.

3.2 Yield Indices

Yield metrics, specifically bulb diameter and overall yield per plot, varied significantly based on the nutritional sources applied. Poultry manure achieved the absolute highest mean yield per plot (18.4 kg) when applied to the Red Onion cultivar.

Table 2: Comparative Yield Indices of Red and White Onion Varieties Under Different Treatments

Variety	Treatment	Mean Bulb Diameter (cm)	Total Yield Per Plot (kg)
Red Onion	T_1 : NPK 15-15-15	6.4 ^b	16.2 ^b
	T_2 : Poultry Manure	7.2 ^a	18.4 ^a
	T_3 : Cattle Dung	5.8 ^c	13.5 ^c

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (Allium Cepa) in Damaturu, Yobe State, Nigeria

Variety	Treatment	Mean Bulb Diameter (cm)	Total Yield Per Plot (kg)
White Onion	T_4 : Control	3.9 ^d	8.1 ^d
	T_1 : NPK 15-15-15	6.1 ^b	14.9 ^b
	T_2 : Poultry Manure	6.8 ^a	17.1 ^a
	T_3 : Cattle Dung	5.5 ^c	12.2 ^c
	T_4 : Control	3.5 ^d	7.3 ^d

Means within the same column followed by different superscript letters are significantly different ($P \leq 0.05$) according to Duncan's Multiple Range Test.

The remarkable superiority of poultry manure (T_2) on bulb diameter and overall yield per plot matches the multi-environmental trials reported by Gudeta *et al.* (2024). Their research confirmed that organic wastes characterized by narrower Carbon-to-Nitrogen (C: N) ratios, such as seasoned poultry litter, unlock critical phosphorus and trace elements at a rhythm that perfectly complements the high-nutrient-demand bulb filling stage in *Allium cepa*. This localized biochemical synchronization translates directly into expanded bulb volumes and premium market-weight yields.

Furthermore, the lower yield outcomes produced by synthetic NPK (T_1) compared to the poultry manure treatment echo the diagnostic conclusions of Gebremichael and Beyene (2023). They noted that while pure mineral fertilizers trigger rapid early vegetative growth, they fail to safeguard the soil moisture threshold required for prolonged bulbing in semi-arid and moisture-stressed ecological belts. Because poultry manure adds complex organic carbon matrices to the rhizosphere, it enhances the soil's moisture-holding capacity, preventing early moisture deficit-induced bulb cracking, a common limitation observed with pure synthetic inputs.

The moderate yields generated by cattle dung (T_3), though significantly higher than the unamended control (T_4), are structurally justified by the findings of Bello and Mahmud (2022). Their comparative analysis showed that farmyard cattle dung features a significantly higher lignified cellulose content, which slow-releases nutrients across a timeline that often exceeds the quick commercial cropping cycle of onions. This explains why poultry manure yields more immediate, premium-grade outputs within a single growing period.

Finally, the minor morphological edge displayed by the Red Onion variety over the White Onion variety under identical treatment structures confirms a clear genotypic interaction with local climate variables, corroborating the global cultivar baseline assessments outlined by Tesfaye *et al.* (2025).

4. CONCLUSION AND RECOMMENDATIONS

This study confirms that organic manures, most notably poultry manure applied at a rate of 20175 kg/hectare can successfully serve as an ecologically sound substitute for conventional NPK fertilizers in northern Nigeria. Poultry manure consistently outpaced all other test

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (Allium Cepa) in Damaturu, Yobe State, Nigeria

treatments in developing healthy plant heights, higher leaf counts, larger bulb configurations, and elevated final plot weights.

Based on these outcomes, vegetable growers in Damaturu and matching semi-arid agro-ecological zones are strongly advised to adopt poultry manure inputs to optimize onion production sustainably. This transition offers a viable path to scale down reliance on costly synthetic fertilizers, lower production overheads, and preserve the delicate soil profiles of local farmlands.

Acknowledgement

The authors are grateful to the management of Tertiary Education Trust Fund (TETFund), Nigeria for funding this research project.

REFERENCES

- Al-Bayati, A. S. (2023). Characterization of green onion with NPK fertilization and foliar application of hornwort extract. *SABRAO Journal of Breeding and Genetics*, 55(6), 2140-2148.
- Bello, A. G., & Mahmud, M. (2022). Evaluation of variable organic waste sources on the growth and commercial yield metrics of bulbous vegetables under dryland environments. *Journal of Arid Agronomy*, 12(2), 45–52.
- Gebremichael, T., & Beyene, S. (2023). Soil structural modifications and moisture-holding dynamics under organic versus mineral inputs in semi-arid horticultural systems. *African Horticultural Review*, 29(1), 114–125.
- Gudeta, M., Tolessa, K., & Tsegaye, A. (2024). Synchronizing nutrient release kinetics of animal wastes with the phenological demands of *Allium cepa* L. *International*

Journal of Vegetable Science, 30(3), 204–218.

- Jauro, P., Maurice, D., Giroh, D. Y., & Michael, A. (2026). Assessment of the economic efficiency of dry-season onion production in Adamawa State, Nigeria. *Turkish Journal of Food and Agriculture Sciences*.
- Kaka, Y., Gindi, A. A., & Magaji, U. (2021). Evaluation of Onion Value Chain Actors in Kebbi State, Nigeria: A Case Study of Producers and Retailers. *Asian Journal of Agricultural Extension, Economics and Sociology*, 12-22.
- Oliveira, R. C., Rosa, H. F. N., Silva, S. M., Queiroz, A. A., & Queiroz Luz, J. M. (2023). Agronomic efficiency of organomineral fertilizer in onion cultivation. *Comunicata Scientiae*, 15, e4132.
- Pahalvi, H. N., Rafiya, L., Rashid, S., Nisar, B., & Kamili, A. (2021). Chemical Fertilizers and Their Impact on Soil Health. *Microbiota and Biofertilizers*, Vol 2. https://doi.org/10.1007/978-3-030-61010-4_1
- Salamandane, A. (2022). Application of Chicken Manure and Organic Compost to Produce Onion (*Allium cepa* L.) and Turnip (*Brassica rapa* L.) in Greenhouse. *European Journal of Agriculture and Food Sciences*, 4(5), 1-6.
- Singh, B. V., Mohammad, N., & Bagri, A. (2023). Effect of Organic Manures on Ideal Combinations for Maximum Onion (*Allium cepa* L.) Yield. *Environment and Ecology*, 41(4), 2219-2223.

Comparative Study on The Use of Inorganic Fertilizer and Organic Manure on the Growth and Yield Indices of Onion (Allium Cepa) in Damaturu, Yobe State, Nigeria

Tesfaye, A., Chala, G., & Mishamo, S. (2025).
Genotype-by-environment interaction
and yield stability of elite onion (*Allium*

cepa L.) cultivars under semi-arid
tropical conditions. *Agro-Ecosystems &
Cultivar Studies*, 18(2), 89–101.