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Effects of fertilizer types on growth and bulb yield of garlic (*Allium sativum* L.) varieties in Ogbomoso, Nigeria

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Abstract

Garlic (*Allium sativum* L.) is an economically and nutritionally valuable crop widely consumed for its culinary and medicinal benefits. However, its productivity in Nigeria remains low, largely due to suboptimal agronomic practices and limited information on appropriate fertilizer types and varietal differences. This study was therefore conducted to evaluate the influence of different fertilizer types and garlic varieties on the growth, and bulb yield of garlic in Ogbomoso.

The treatment consisted of two garlic varieties (Sokoto local and Pretty garlic) and six fertilizer treatments: F1 (No fertilizer), F2 (100% NPK 15-15-15), F3 (100% Compost), F4 (50% NPK + 50% Compost), F5 (75% NPK + 25% Compost), and F6 (75% Compost + 25% NPK). The 2 × 6 factorial experiment was arranged in a Completely Randomized Design (CRD), replicated four times. Data were collected on growth, yield and yield parameters. Data collected were subjected to Analysis of variance (ANOVA) and treatment means were separated using Duncan's Multiple Range Test at a 5% significance level.

Results showed that Pretty garlic was significantly higher ($p \leq 0.05$) in all growth and yield parameters than Sokoto local variety. Although, Sokoto local variety demonstrated more vigorous early growth, with higher numbers of leaves, tillers, clove count per bulb, and greater bulb firmness. Among the fertilizer treatments, 100% compost significantly enhanced ($p \leq 0.05$) vegetative growth, while the combination of 50% NPK + 50% compost resulted in the highest bulb yield (138.67 kg/ha). A significant interaction ($p \leq 0.05$) was observed between variety and fertilizer type for all data collected, indicating that the response of garlic to fertilizer application is variety-dependent.

In conclusion, pretty garlic variety fertilized with integrated application of 100 kg/ha NPK 15:15:15 + 5 tons/ha Tithonia compost were recommended for optimum production of garlic in the study area.

Keywords: Garlic, growth, bulb yield, fertilizers, varieties

Introduction

Garlic (*Allium sativum* L.), a member of alliaceae family and second most widely cultivated spice bulb crop after onion. It originated from central Asia. It is a high-value horticultural crop known for its culinary, medicinal, and nutritional benefits. It belongs to the family Amaryllidaceae and is widely grown for its bulbs, which contain bioactive compounds such as allicin, with antibacterial, antifungal, and antihypertensive properties (Ayoola *et al.*, 2023) [2]. Garlic exhibits significant genetic variability in morphological and physiological traits, which directly influence its growth and yield potential. The selection of suitable varieties is critical, as garlic is a vegetative propagated crop with limited genetic recombination, making clonal selection the primary means of varietal improvement (Kumar *et al.*, 2022) [3]. Differences among varieties can result in notable variations in plant height, leaf number, bulb size, clove number, and total yield, influenced by both genetic makeup and environmental interactions (Singh and Verma, 2023) [5].

Soil fertility management is one of the most crucial factors influencing crop growth and productivity. Fertilizer application plays a vital role in enhancing the growth attributes and bulb yield of garlic. However, the type of fertilizer used whether organic (e.g., poultry manure), inorganic (e.g., NPK formulations), or integrated can have varying impacts on plant performance and soil health (Yusuf *et al.*, 2023) [6]. Inorganic fertilizers, while promoting rapid growth, may lead to soil degradation over time if used indiscriminately.

In contrast, organic fertilizers improve soil structure and microbial activity but may release nutrients more slowly (Adebayo and Ojo, 2021) ^[1]. Despite its potential for garlic cultivation, there is a lack of empirical data on the optimal fertilizer strategies for different garlic varieties in this region. In Nigeria, garlic cultivation is still limited compared to other *Allium* crops like onion, partly due to low yield, poor soil fertility, and the absence of location-specific fertilizer recommendations (Olatunji and Fasasi, 2022) ^[4]. Therefore, this study aims to evaluate the effects of different fertilizer types on the growth and bulb yield of garlic varieties in Ogbomoso.

Materials and Methods

Experimental site

The pot experiment was conducted to determine the effects of fertilizer types on growth and bulb yield of garlic (*allium sativum* L.) varieties in Ogbomoso, Nigeria at Teaching and Research farm, LAUTECH, Ogbomoso. Oyo State, Nigeria. Experimental treatments consisted of two varieties of garlic (Pretty garlic and Sokoto garlic) and six levels of fertilizer types (Control, 100% NPK 15-15-15, 100% Compost, 50% NPK+ 50% Compost, 75% NPK+ 25% Compost, 75% compost + 25% NPK). The treatment were arranged factorial experiment arranged in completely randomized design (CRD) replicated four times. Polypots (30 x 27 cm) were perforated and filled with 5kg top soil each. Priming was carried out on the garlic clove for 14 hours before planting, planting of one clove /pot with planting depth of 2cm. Fertilizer was applied two weeks after plant Data collected were collected on Plant Height (cm), Number of leaves/plant, Number of tillers, Bulb Diameter (cm), Bulb length (cm), Number of clove/bulb, Bulb weight (g/plant), Bulb firmness rating, Bulb Rottening%, Bulb yield, Drymatter yield, Plant weight and Number of root/bulb Data Analysis: Data collected were subjected to Analysis of Variance (ANOVA) following the Gomez and Gomez (1991) and means compared using Duncan's Multiple Range Test (DMRT) at 5% probability level.

Results and Discussion

Plant height

Plant height in garlic was significantly influenced by both variety and fertilizer type across most stages of growth, with notable varietal differences beginning at 2 weeks after planting (WAP) and persisting through 12 WAP. The interaction between variety and fertilizer ($F \times V$) was also statistically significant at 2, 4, 10, and 12 WAP, indicating that the response to fertilizer varied between the garlic varieties at specific stages. Variety V2 consistently produced taller plants than V1, with a significant difference emerging from 4 WAP onward (V2: 24.26 cm, V1: 17.5 cm), and maintained this advantage through 12 WAP (V2: 45.09 cm, V1: 43.25 cm). This suggests that V2 has a more vigorous vertical growth habit, potentially due to greater genetic adaptability or nutrient use efficiency, as supported by similar findings from Kumar *et al.* (2022) ^[3] and Singh and Verma (2023) ^[5].

Fertilizer application had a pronounced impact on plant height, with F3 (100% Compost) consistently producing the tallest plants at all growth stages (51.50 cm at 12 WAP), followed closely by F4 and F5. These treatments likely provided a balanced and sustained nutrient supply, possibly combining organic and inorganic components. The control

(F1) and F6 showed the poorest performance, especially from 6 WAP onward, suggesting limited or slow nutrient availability. The significant $F \times V$ interaction at both early and late stages implies that specific fertilizer-variety combinations (V2 with F3) enhanced growth more effectively. During mid-growth stages (6 and 8 WAP), the interaction was not significant, possibly due to uniform vegetative expansion. Generally, plant height increased from 2 to 10 WAP, with a slight plateau by 12 WAP, reflecting garlic's natural growth pattern as it transitions to the bulbing phase.

Number of leaves

The number of leaves in garlic was significantly affected by both variety and fertilizer type across the growing period. At 2 weeks after planting (WAP), variety V1 exhibited a significantly higher leaf count (1.22) than V2 (0.62), indicating superior early vegetative vigor. However, from 4WAP to 12WAP, varietal differences were no longer statistically significant, as both genotypes showed comparable leaf numbers. By 12WAP, V2 slightly surpassed V1 (3.94 vs. 3.83), though this difference remained non-significant. This pattern suggests that varietal influence on leaf proliferation is most prominent during early growth stages, consistent with Singh and Verma (2023) ^[5], who noted that early seedling vigor plays a key role in early development and establishment.

Fertilizer application had a more consistent and pronounced effect on leaf number across all stages. F3 (100% Compost) recorded the highest leaf counts throughout, peaking at 10.12 leaves at 8WAP and gradually declining thereafter, indicative of its role in supporting vigorous vegetative growth. In contrast, F1 (no fertilizer) consistently produced the fewest leaves, while moderate responses were observed in F2, F4, and F5. F6 also underperformed, similar to F1. The interaction between variety and fertilizer ($F \times V$) was significant at most growth stages (2, 4, 8, 10, and 12 WAP), suggesting differential varietal responses to fertilizer types across phenological stages. A general trend of increasing leaf number was observed until 8-10 WAP, followed by a decline at 12 WAP, likely marking the transition from vegetative growth to bulb initiation, aligning with garlic's typical physiological development (Kumar *et al.*, 2022; Yusuf *et al.*, 2023) ^[3, 6].

Number of tillers

The number of tillers (NT) in garlic was significantly affected by both variety and fertilizer type, particularly from 6 weeks after planting (WAP) onward. At early growth stages (2 and 4 WAP), both varieties showed similar tillering capacity (V1: 1.13; V2: 1.05), indicating no statistical difference. However, from 6 to 8 WAP, V1 produced significantly more tillers than V2, suggesting early vegetative vigor. By 10 and 12 WAP, the trend reversed, with V2 surpassing V1 in tiller number (V2: 0.91; V1: 0.69), indicating sustained tillering into the reproductive phase. These varietal differences align with the findings of Kumar *et al.* (2022) ^[3], who attributed such variation to genotype-specific growth habits and hormonal regulation, where early-maturing genotypes exhibit early tillering and late-maturing types sustain vegetative activity longer.

Fertilizer treatments also had a pronounced impact on tiller production. F3 consistently recorded the highest tiller numbers across all growth stages (1.50 tillers from 2 to 8

WAP; 0.95 at 10-12 WAP), indicating efficient nutrient support for prolonged vegetative development. In contrast, F6 had the lowest tiller counts (1.00 at early stages; 0.58 by 10 WAP), likely due to inadequate nutrient availability. Intermediate responses were observed in F1, F2, F4, and F5, with F4 showing moderate values (1.16 at 6 WAP; 0.83 at 10 WAP). The interaction between variety and fertilizer ($F \times V$) was not significant at early stages but became significant at 6, 8, 10, and 12 WAP, suggesting that specific variety-fertilizer combinations are more effective in promoting sustained tillering. These findings, supported by Yusuf *et al.* (2023) [6], highlight the importance of matching appropriate fertilizer types with garlic varieties to optimize vegetative growth and potential yield.

Yield and yield components

The study revealed significant effects of garlic variety, fertilizer type, and their interaction ($p < 0.01$) on key morphological, yield, and quality traits. Pretty garlic (V2) produced significantly larger bulbs (4.37 cm diameter), higher plant weight (11.78 g), dry matter content (3.99 g), and bulb yield (0.6 g/plant) compared to Sokoto local (V1). In contrast, V1 excelled in clove number (2.20 per bulb) and bulb firmness (4.11), indicating genotypic influence on bulb structure and early vigor. These varietal differences align with prior reports linking genetic traits to nutrient partitioning and market quality.

Fertilizer treatments also significantly influenced performance. F4 (50% NPK + 50% Compost) consistently enhanced bulb diameter (7.23 cm), bulb firmness (4.75), and overall yield (1.04 g/plant), while F3 (100% Compost) promoted superior vegetative growth, root development, and tillering. F2 (100% NPK) supported larger bulb length and clove count. Fertilizer interaction effects ($F \times V$) were significant across all parameters, highlighting the importance of tailored fertilization. Bulb rotting was lowest under F1 but highest under F4, suggesting excessive nutrients may increase susceptibility to decay. Root number

was maximized with F3, F5, and F6, indicating organic amendments support robust root systems. These results confirm that integrated nutrient strategies—especially the combination of Pretty garlic and F4 offer the best outcomes for maximizing garlic productivity and quality under Ogbomoso conditions.

Recommendation

The findings from this study clearly demonstrate that both garlic variety and fertilizer type significantly influenced the growth, and yield of garlic under the agro-ecological conditions of Ogbomoso, Nigeria. Pretty garlic (V2) showed superior performance in plant height, biomass accumulation, dry matter yield, and final bulb yield, whereas Sokoto local (V1) had advantages in early-stage vegetative traits such as leaf number, tiller count, and clove number per bulb. Fertilizer application, particularly F4 (50% NPK + 50% Compost), produced the highest yield and bulb quality attributes, while F3 (100% Compost) consistently enhanced vegetative growth and root development. The significant interaction between variety and fertilizer type across all measured parameters emphasizes the importance of matching specific varieties with appropriate nutrient sources to optimize growth and productivity.

Based on these results, it is recommended that garlic farmers in Ogbomoso and similar agro-ecological zones adopt Pretty garlic variety in combination with F4 fertilizer treatment (50% NPK + 50% Compost) to maximize bulb yield and market quality. Where the focus is on early growth vigor or clove production, Sokoto local variety with 100% Compost (F3) may be more suitable. Extension services should promote integrated nutrient management strategies that combine organic and inorganic fertilizers tailored to specific garlic varieties to enhance sustainable production. Further research is encouraged to evaluate long-term soil health impacts and economic viability of these fertilizer combinations under field conditions.

Table 1: Effect of variety and fertilizer type on plant height (cm) of garlic at different sampling periods

Treatments	PH2WKS	PH4WKS	PH6WKS	PH8WKS	PH10WKS	PH12WKS
Variety						
V1	7.85a	17.5b	27.11b	34.11b	40.47b	43.25a
V2	4.90a	24.26a	37.65a	42.52a	45.06a	45.09a
Fertilizer Types						
F1	1.89b	10.19b	19.33c	25.12c	31.22c	34.83c
F2	6.23ab	20.62a	33.54ab	39.81ab	44.33ab	43.91ab
F3	9.65a	25.12a	40.68a	48.10a	51.00a	51.50a
F4	8.38a	26.26a	35.95ab	41.06ab	45.22ab	47.08a
F5	8.23a	25.22a	36.71ab	41.75ab	45.79ab	47.87a
F6	5.89ab	18.15ab	28.08bc	34.04bc	39.04bc	39.83bc
F×V	**	**	NS	NS	*	*

F1-No fertilizer, F2-100% NPK 15-15-15, F3- 100% Compost, F4- 50% NPK 15-15-15+50% Compost F5- 75%NPK+25% Compost,F6- 75% compost +25% NPK

Table 2: Effect of variety and fertilizer type on number of leaves of garlic at different sampling periods

Treatments	NL2WKS	NL4WKS	NL6WKS	NL8WKS	NL10WKS	NL12WKS
Variety						
V1	1.22a	3.54a	5.48a	6.77a	6.81a	3.83a
V2	0.62b	3.33a	5.15a	6.68a	6.77a	3.94a
Fertilizer Types						
F1	0.50c	2.37c	3.83b	5.08c	5.83b	3.16b
F2	0.66ab	2.66bc	4.79b	6.12bc	6.83b	4.04b
F3	1.37a	6.04a	8.37a	10.12a	8.62a	5.16a
F4	1.12abc	3.66b	5.29b	7.08b	6.87b	3.91b
F5	1.29ab	3.45bc	5.33b	6.33bc	6.75b	3.70b
F6	0.58bc	2.41bc	4.62c	5.62c	5.87b	3.33b
FxV	*	*	NS	*	*	*

F1-No fertilizer, F2-100% NPK 15-15-15, F3- 100% Compost, F4- 50% NPK 15-15-15+50% Compost F5- 75%NPK+25% Compost,F6- 75% compost +25% NPK

Table 3: Effect of variety and fertilizer type on number of tillers of garlic at different sampling periods

Treatments	NT2WKS	NT4WKS	NT6WKS	NT8WKS	NT10WKS	NT12WKS
Variety						
V1	1.13a	1.13a	1.22a	1.22a	0.69b	0.69b
V2	1.05a	1.05a	1.05b	1.05b	0.91a	0.91a
Fertilizer Types						
F1	1.00b	1.00b	1.00b	1.00b	0.91a	0.91a
F2	1.04b	1.04b	1.12b	1.12b	0.79ab	0.79ab
F3	1.50a	1.50a	1.50a	1.50a	0.95a	0.95a
F4	1.04b	1.04b	1.16b	1.16b	0.83ab	0.83ab
F5	1.00b	1.00b	1.04b	1.04b	0.75ab	0.75ab
F6	1.00b	1.00b	1.00b	1.00b	0.58b	0.58b
FxV	NS	NS	*	*	**	**

F1-No fertilizer, F2-100% NPK 15-15-15, F3- 100% Compost, F4- 50% NPK 15-15-15+50% Compost F5- 75%NPK+25% Compost,F6- 75% compost +25% NPK

Table 4: Effect of variety and fertilizer type on yield and yield components of garlic at different sampling periods

Treatment	BD	BL	No of clove/bulb	Plant weight	% Bulb rotting	BW	No of root/plant	Bulb firmness	Drymatter yield	Bulb yield
Variety										
V1	3.11b	3.07a	2.20a	7.83b	1.73a	3.21a	28.26a	4.11a	1.33b	0.4b
V2	4.37a	2.99a	1.06b	11.78a	1.87a	2.76a	30.77a	3.52a	3.99a	0.6a
Fertilizer Types										
F1	1.70c	2.67ab	1.79ab	10.73a	1.45c	3.11a	27.79a	3.91a	2.09a	0.33c
F2	4.61b	3.58a	2.25a	9.91a	1.58bc	3.00a	26.66a	3.62a	2.57a	0.71b
F3	2.8cc	2.60b	1.58ab	9.37a	1.83bc	3.17a	31.50a	3.41a	3.06a	0.44c
F4	7.23a	2.92ab	1.83ab	9.68a	2.29a	3.12a	28.79a	4.75a	2.81a	1.04a
F5	2.83c	3.02ab	1.12b	9.34a	1.95ab	2.57a	31.95a	3.41a	3.09a	0.39c
F6	3.17bc	3.19ab	1.25b	9.81a	1.70bc	2.92a	30.41a	3.79a	2.33a	0.43c
FxV	**	**	**	**	**	**	**	**	**	**

F1-No fertilizer, F2-100% NPK 15-15-15, F3- 100% Compost, F4- 50% NPK 15-15-15+50% Compost F5- 75%NPK+25% Compost,F6- 75% compost +25% NPK

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