





Response of Cowpea (*Vigna unguiculata* (L) Walp) Varieties to Varied Phosphate Fertilizers in Acidic Soil of Shira Town, Bauchi State, Nigeria

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Abstract	Article History
<p>Cowpeas are mainly cultivated in Africa, especially in Nigeria and Niger, which together contribute the largest share of global production. This study investigates the response of cowpea (<i>Vigna unguiculata</i>) variety to varied phosphate fertilizers in acidic soil of Shira, Bauchi State Nigeria. Soil samples were collected from Shira, Nigeria and analyzed for their acidity and some physicochemical parameters which include; pH, electrical conductivity (EC mS/m), exchangeable acidity (EA cmol/kg) and phosphorous content (P mg/kg). Nine (9) selected cowpea varieties were planted in the soil samples treated with lime, phosphate rock (PR) and organo minerals phosphorous fertilizer (OMF) as well as a combination of lime and OMF. The experimental set up was a factorial design with five treatment (including control) and three replicates. Data was collected for growth parameters which included plant height, stem girth and number of leaves, leaf area and number of seeds per plant. The results indicated that soil sample collected from Shira showed a sandy loam texture composed of 60% sand, 16% silt, and 24% clay, indicating dominance of sand (60%). The soil was strongly acidic with average a pH of 4.50, an electrical conductivity (EC) of 5.7mS/m, and exchangeable acidity (EA) of 0.17cmol/kg. Among cowpea varieties, IT97-49-35 recorded the highest plant height (27.7 cm), followed closely by IT98K-205-8 (27.4 cm) and IT09-131-1 (27.0 cm), while IT97K-819-118 had the lowest (15.9 cm). Dansaminu produced the highest stem girth (4.0 mm), whereas IT97K-819-118 had the least (2.0mm). For leaf production, IT97-49-35 recorded the highest number of leaves (19.4), while IT98K-57-1-1 had the lowest (12.2). Leaf area was highest in IT97-49-35 and IT98K-205-8 (24.2), but lowest in IT07K-230-2-9 (18.2). Seed production was highest in Dansaminu (29.1) and lowest in IT97K-819-118 (15.0). More so, OMF plus Lime gave the highest plant height (35.0 cm) and stem girth (3.7), while Lime alone recorded the lowest (11.5 cm). OMF produced the highest number of leaves (23.6), whereas Lime and Control had the lowest (7.6). Leaf area was highest under OMF plus Lime and OMF (36.0), while Lime recorded the least (7.9). Similarly, OMF produced the highest seed number (33.7), while Lime had the lowest (8.3). The study revealed that the application of OMF and OMF plus Lime improved the growth and yield performance of cowpea varieties under the acidic sandy loam soil conditions of Shira. OMF plus Lime produced the highest plant height, stem girth, and leaf area, while OMF alone resulted in the highest number of leaves and seeds. Among the cowpea varieties evaluated, IT97-49-35 and Dansaminu showed superior performance in most growth and yield parameters compared to the other varieties studied.</p> <p>Keywords: Soil acidity, Lime, Cowpea varieties, Organic Mineral Fertilizer, <i>Vigna unguiculata</i>.</p>	<p>Received: 13 Jul 2025 Accepted: 12 Oct 2025 Published: 10 Nov 2025</p>  <p>Scan QR code to view*</p> <p>License: CC BY 4.0*</p>  <p>Open Access article.</p>
<p>How to cite this paper: Abubakar, A., Kamal, A., Zigau, Z. A., & Tijjani, H. (2025). Response of Cowpea (<i>Vigna unguiculata</i> (L) Walp) Varieties to Varied Phosphate Fertilizers in Acidic Soil of Shira Town, Bauchi State, Nigeria. <i>Journal of Agriculture, Food Technology and Sustainability</i>, 2(1), 102–106. https://doi.org/10.54117/jafts.v2i1.164</p>	

Introduction

Most cowpeas are grown on the African continent, particularly in Nigeria and Niger, which account for 72% of world cowpea production. The Sahel region also contains other major producers such as Burkina Faso, Ghana, Senegal, and Mali. Niger is the main exporter of cowpeas, while Nigeria is the main importer. It is difficult to state the exact figures for cowpea production

because the crop is not an important export commodity. An estimated 12.5 million hectares were used for cowpea cultivation as of 1997, with a worldwide production of up to three million tons. The crop plays a key role in subsistence farming and in the generation of fodder for livestock. It is considered one of the major cash crops in Central and West Africa because about 200

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million people are believed to consume it daily (Osho *et al.*, 1997; FAO, 2012).

Cowpea production is often limited by acid soil infertility. The degree of acidity or alkalinity (i.e., soil reaction) is a master variable that affects all soil properties, including chemical, physical, and biological properties. Expressed as pH, this variable largely controls plant nutrient availability and microbial activity in soils. A soil test is the best way to determine soil nutrient levels. Soil acidity is commonly reduced by adding carbonates, oxides, or hydroxides of calcium and magnesium, compounds referred to as agricultural lime. Where soils are highly acidic, cowpea growth can be dramatically improved through liming (Obiri-Nyarko, 2012; Wong *et al.*, 1998).

Soil pH commonly fluctuates depending on its location, origin, or the type of processing carried out on it in the case of purchased soil. Areas that naturally have more acidic soils are usually those with higher precipitation rates. Water washes away certain nutrients from the soil. Soils derived from acidic rocks such as silica-rich rocks, or soils that have been heavily fertilized, often have lower pH values as well (Fatokun *et al.*, 2002).

In acidic soils, nutrient availability is reduced, making cowpea more vulnerable to pest pressure. Common pesticides such as cypermethrin, chlorpyrifos, carbaryl, and neem-based biopesticides help reduce insect damage (Abubakar *et al.*, 2020), while phosphate fertilizers improve nutrient uptake under low pH conditions. Together, they could enhance cowpea yield and productivity (Boukar *et al.*, 2019).

Conventional lime remains the major means of ameliorating soil acidity; however, most farmers find it difficult to purchase, coupled with the subsoil acidity associated with inadequate liming practices. Basically, inputs into the soil such as inorganic fertilizer application, biological nitrogen fixation, and acid rain have been identified as causes of soil acidity. Similarly, soil amendments capable of increasing soil pH could be exploited to correct the twin problems of low pH and phosphorus deficiency (Enesi *et al.*, 2023). When rock phosphate (RP) is added to acidic soils, phosphorus availability can increase due to the phosphorus-supplying ability of these materials. Because of their calcium and magnesium contents, RP plays a significant role as a potential tool for sustaining soil productivity by reducing soil acidity. Therefore, it is important to consider the liming abilities of calcium-containing fertilizers such as RP, SSP, and organic fertilizers, in addition to their phosphorus-supplying properties (Zapata, 2000). This study evaluated the response of *Vigna unguiculata* (L.) Walp. (Cowpea) varieties to different phosphate fertilizers in the acidic soils of Shira Town, Bauchi State, Nigeria.

Materials and Methods

Collection of Soil Sample

Soil sample were collected in sterile polythene bag from Shira town, Shira local government area of Bauchi State, Nigeria. Shira town is located at approximately 11.4530°N latitude and 10.0538°E longitude. The town sits at an elevation of 453 meters above sea level and serves as a significant locality within the Shira Local Government Area, Bauchi State, Nigeria.

Acidic Soil Test

A quick test was carried out on the sample to determine the level of acidity. This was done by adding three tablespoon full of

baking soda to 50g of the soil mixed with water in container. Appearance of air bubbles indicated that the soil samples were acidic.

Soil analysis

Soil pH was determined using electrode pH meter as described by Thomas 1996. Exchangeable acidity EA (coml/kg) in soil was determined using KCl extraction method as described by Maclean (1982). Phosphorus P (mg/kg) was determined using Bray No 1 method (Bray and Kurtz, 1945).

Collection and Planting of Cowpea Seeds

Nine (9) cowpea varieties comprising seven (7) improved and two (2) local were collected from the International Institute of Tropical Agriculture (IITA), Kano station (Table 1).

Table 1. Origin of the Cowpea Varieties used during the study.

Variety	Origin	Growth type
IT97-499-35	IITA	Early
IT98K-573-1-1	IITA	Early
IT09-131-1	IITA	Early
IT98K-205-8	IITA	Early
ITO8K-149-3	IITA	Early
IT97K-819-118	IITA	Early
ITO7K-230-2-9	IITA	Early
Dansaminu	Local	Medium
Kanannado	Local	Late

Experimental Set Up

Polythene pots of 603cm³ capacity were $\frac{3}{4}$ filled with the soil samples collected from Shira town, Nigeria. Four (4) treatments with three (3) replicates each were prepared in respect of each of the nine (9) cowpea varieties. For the first treatment, the soil sample was mixed with three (3) tablespoon full of Lime and this was replicated 3 times for each cowpea variety. The same procedure was repeated with respect of the other treatments using organo minerals phosphorous fertilizer (OMF), phosphate rock (PR) and a combination of OMF and Lime (OM F+ Lime). A control was also set up were the poly pots were filled with the soil from the sampling site only. Three (3) cowpea seeds were sown in holes spaced 2cm apart in each of the pots. Watering and hand weeding were done as and when required. Spraying with Lambda cyhalothri (25%) was carried out three (3) times to take care of insect pests. The trial was set in a factorial design.

Parameters Measured

The following parameters were determined during the study period at the interval of 2, 4, 6, and 8 weeks after planting.

Plant height

Plant height was measured by means of a meter rule which was from the soil surface to the tip of the plant. The average value for the three (3) replicates was recorded.

Stem girth

This was obtained by means of a vernier caliper. The caliper was gripped around the stem of a plant from each of the three (3) pots

representing replicates of each treatment. The average reading was taken and recorded.

Number of leaves

These were done by counting the leaves on the 3 replicated plants and the average reading was taken and recorded.

Leaf area

This was calculated as the product of the total length and breadth at the broadest point of the longest leaf on the plant. It was done by measuring the 3 replicated plants using a meter rule and the average reading was taken and recorded.

Number of seeds per plant

This was obtained by counting the number of seeds of the plants in each pot and the average was taken for the three (3) replicates and recorded.

Data Analysis

The data collected were subjected to analysis of variance (two-way ANOVA) using SPSS Tukey software following a procedure appropriate to RCBD. Means separation was done using Tukey posthoc test at $P < 0.05$.

Results and Discussion

The particle size distribution and textural classification of the soil sample collected from Shira Nigeria are presented on Table 2. The soil contains 60% sand, 16% silt, and 24% clay. Based on these proportions, the soil is classified as sandy loam. This indicates that sand is the dominant particle fraction, giving the soil relatively good drainage and aeration, while the presence of silt and clay helps retain moisture and nutrients. The soil sample collected during the 2024 raining season from Shira Nigeria was acidic, with a pH value of 4.50. An electrical conductivity (EC) value of 57 was recorded, while the exchangeable acidity (EA) value was 0.17 (Figure 1).

Table 2. Particle size distributions of the soil samples collected from Shira Bauchi, Nigeria

Soil texture	Value
Sand (%)	60
Silt (%)	16
Clay (%)	24
Textural class	Sandy loam

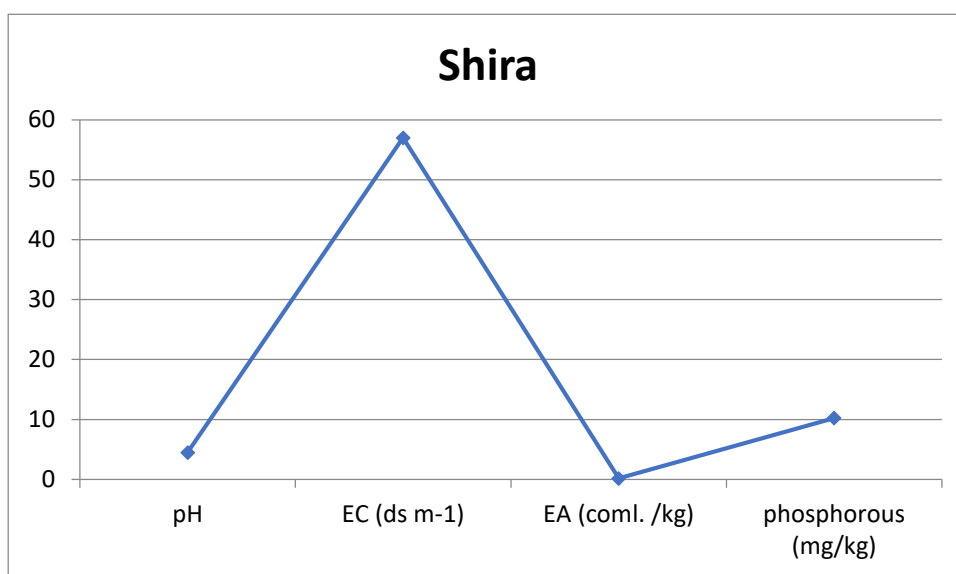


Figure 1. Physicochemical properties of the soil (0-15 cm) from Shira town, Shira Local Government of Area, Bauchi State, Nigeria
EC = Electrical conductivity, EA = Exchangeable acidity

The analysis of variance table indicates that there were significant differences within the treatments and also within the varieties at $p < 0.05$ for plant height, stem girth and number of seeds. But no significant differences were recorded between the varieties, for number of leaves and leaf area (Table 3). Conversely significant differences were recorded between the treatments for number of leaves and leaf area at $p < 0.05$.

The cowpea variety IT97-499-35 recorded the highest mean value for plant height (27.7cm) which was slightly higher than IT98K-205.8 and IT09-131 -1 that recorded 27.4cm and 27.0cm respectively (Table 4). While the variety that recorded the shortest was IT97K-819-118 with 15.9 cm mean value. Dansaminu had the highest stem girth among the varieties (4.0) while IT97K-819-118 recorded the least (2.0). In terms of leaves number, IT97-49-35 recorded the highest with an average of 19.4. On the other hand, IT98K-573-1-1 recorded

the least (12.2). IT97-499-35 and IT98K-205-8 had 24.2 as their mean leaf area, which was the highest and the lowest was recorded for ITO7K-230-2-9 (18.2). Conversely, 29.1 mean number of seeds was the highest and it was recorded by Dansaminu, while 15.0 was the least which was recorded by IT97K-819-118.

In terms of acidity (treatments) OMF +LIME had the highest plant height and stem girth mean values while LIME recorded the least. The values were 35.0, 11.5, 3.7 and 2.1 respectively (Table 5). However OMF had 23.6 number of leaves mean value, which was the highest while LIME and the control had the least (7.6). But in terms of leaf area the highest value was 36.0, recorded by OMF +LIME and OMF. LIME recorded the least leaf area mean value with 7.9. The highest number of seeds was 33.7 for OMF and the least was 8.3 for LIME.

Table 3. Analysis of variance for plant height, stem girth, number of leaves, leaf area and number of seeds on Shira soil, Shira Bauchi, Nigeria

Source	DF	Adj MS (Plant Height)	Adj MS (Stem Girth)	Adj MS (Number of Leaves)	Adj MS (Leaf Area)	Adj MS (Number of Seeds)
Varieties	8	212.8**	4.889**	76.57	86.6	285.5**
Acidity	4	2909.8**	12.125**	1601.81**	5277.4**	3968.3**
Residual	122	65.4	1.61	61.06	44.3	42.4

** indicate significant difference at $p < 0.05$, DF = degree of freedom, Adj MS = adjusted means of square

Table 4. Performance of cowpea varieties cultivated on Shira soil, Shira Bauchi, Nigeria

Variety	Plant Height	Stem Girth	Number of Leaves	Leaf Area	Number of Seeds
IT09-131-1	27.0 ± 2.0	2.9 ± 0.4	17.4 ± 1.9	20.6 ± 1.8	24.0 ± 1.6
IT97-499-35	27.7 ± 2.2	2.7 ± 0.2	19.4 ± 2.1	24.2 ± 1.6	21.2 ± 1.8
IT97K-819-118	15.9 ± 1.8	2.0 ± 0.4	14.8 ± 1.7	18.4 ± 1.9	15.0 ± 1.5
IT98K-573-1-1	24.4 ± 2.3	2.8 ± 0.2	12.2 ± 1.8	21.0 ± 1.5	23.8 ± 1.9
Dansaminu	22.9 ± 2.0	4.0 ± 0.4	12.9 ± 2.2	22.9 ± 1.8	29.1 ± 1.6
IT98K-205-8	27.4 ± 2.1	3.0 ± 0.3	14.2 ± 1.9	24.2 ± 1.7	18.2 ± 1.8
IT07K-230-2-9	21.1 ± 1.9	2.2 ± 0.2	13.6 ± 2.1	18.2 ± 1.6	17.8 ± 1.5
IT08K-149-3	24.0 ± 2.2	2.5 ± 0.4	15.0 ± 1.8	23.4 ± 1.9	17.1 ± 1.7
Kanannado	25.9 ± 2.0	2.8 ± 0.3	16.0 ± 2.0	23.9 ± 1.6	19.4 ± 1.8

Values are mean ± standard deviation

Table 5. Effects of treatments on cowpea varieties cultivated on Shira soil, Shira Bauchi, Nigeria

Treatment	Plant Height	Stem Girth	Number of Leaves	Leaf Area	Number of Seeds
Control	14.5 ± 1.5	2.3 ± 0.3	7.6 ± 1.4	8.2 ± 1.2	9.3 ± 1.4
Lime	11.5 ± 1.7	2.1 ± 0.2	7.6 ± 1.6	7.9 ± 1.4	8.3 ± 1.2
OMF	30.8 ± 1.5	3.2 ± 0.3	23.6 ± 1.7	36.0 ± 1.4	33.7 ± 1.2
OMF + Lime	35.0 ± 1.8	3.7 ± 0.3	22.3 ± 1.4	36.0 ± 1.2	32.0 ± 1.5
PR	28.4 ± 1.6	2.5 ± 0.2	14.2 ± 1.6	21.3 ± 1.5	19.5 ± 1.4

Values are mean ± standard deviation. SE = standard error, OMF = organo mineral phosphorus fertilizer, PR= phosphate rock.

The result indicated that OMF in combination with lime is effective for the growth of cowpea. The increase in plant height is associated with increase in nitrogen, phosphorus and potassium level in the soil as affirmed by Reyhan and Amiraslan (2006). The studies show that the stem diameter of plant treated with OMF alone and in combination with lime in moderate concentration significantly influenced thicker stem.

The studies also show an increase in number of leaves and leaf area of cowpea. This was due to the effect of OMF and PR in particular promoting growth, stimulation and development of leaves (Obiri-Nyarko, 2012).

Seed yields were also significantly affected by the application of OMF and in combination with lime. The increase in seed yield observed in this study was attributing to the enhanced vegetative growth (leaf area and number of leaf/plant). The environment also in which cowpea are grown has been reported to be of great importance to cowpea seed yield (Boukar *et al.*, 2019). Sustainable cowpea production in acidic soils may require an integrated approach combining phosphorus fertilization, soil acidity management, and environmentally friendly pest control methods such as homemade biopesticides (Adetunji *et al.*, 2020).

Conclusion

The findings of this study demonstrated that organo-mineral fertilizer (OMF), particularly when combined with lime, significantly improved the growth and yield performance of cowpea grown under acidic soil conditions. The application of OMF enhanced important growth parameters such as plant height, stem diameter, number of leaves, and leaf area, which may be attributed to improved soil nutrient availability,

especially nitrogen, phosphorus, and potassium. The combination of OMF with lime further improved soil conditions by reducing acidity and enhancing nutrient uptake efficiency.

In addition, seed yield was significantly increased by the application of OMF alone and in combination with lime. The enhanced yield observed in this study could be linked to improved vegetative growth and better physiological performance of the crop. The study therefore confirms that integrated soil fertility management involving OMF and lime can promote sustainable cowpea production in acidic soils. Farmers cultivating cowpea on acidic soils should adopt the combined application of organo-mineral fertilizer and lime to improve soil fertility, plant growth, and seed yield. Moderate rates of OMF combined with lime are recommended, as they were found to produce better growth performance and thicker stem development in cowpea plants.

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