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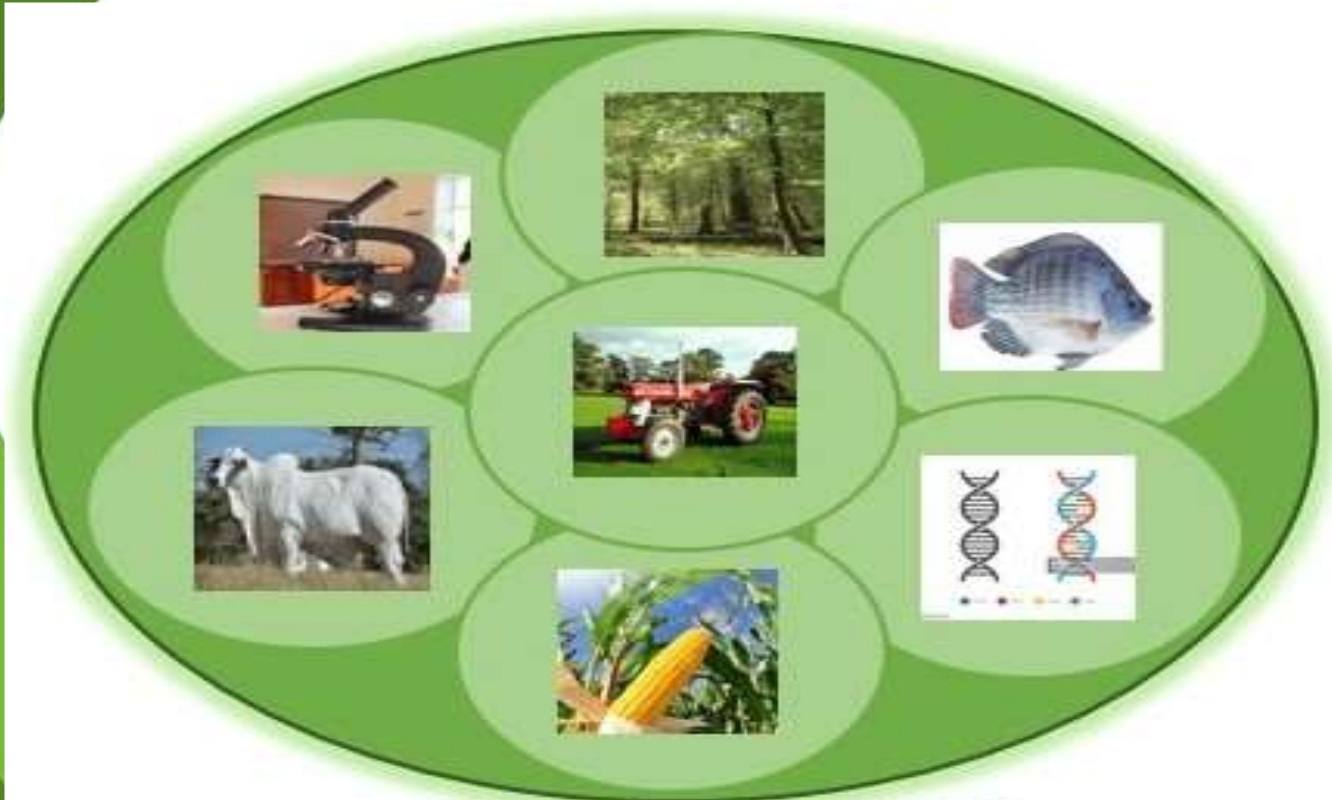

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Scope of Kebbi Journal of Agriculture and Natural Sciences (KEJAANS)

The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

EFFECTS OF NITROGEN AND POTASSIUM FERTILIZER ON GROWTH PERFORMANCE AND YIELD OF CASSAVA (*Manihot esculenta* Crantz) IN THE DERIVED SAVANNA ZONE OF DELTA STATE, NIGERIA

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ABSTRACT

This study was conducted to evaluate the influence of Nitrogen (N) and Potassium (K) fertilizers on the growth and yield performance of Cassava (Manihot esculenta) at Igbodo (5°45′N, 6°30′E) in Delta State, Nigeria. The experiment utilized a 4×4 factorial design within a Randomized Complete Block Design (RCBD), replicated three times. The following treatment combinations were applied N_0K_0kg/ha, N_0K_{20}kg/ha, N_0K_{40}kg/ha, N_0K_{80}kg/ha, $N_{40}K_0$kg/ha, $N_{40}K_{20}$kg/ha, $N_{40}K_{40}$kg/ha, $N_{40}K_{80}$kg/ha, $N_{80}K_0$kg/ha, $N_{80}K_{20}$kg/ha, $N_{80}K_{40}$kg/ha, $N_{80}K_{80}$kg/ha, $N_{120}K_0$kg/ha, $N_{120}K_{20}$kg/ha, $N_{120}K_{40}$kg/ha and $N_{120}K_{80}$kg/ha. Soil samples were analyzed for physic-chemical properties, and cassava variety 01/1797 was planted. Growth parameters such as plant height, leaf number, and leaf area were measured at 2, 4, 6, 8, and 10 months after planting (MAP). Yield data, including fresh tuber weight, dry matter content, and peel weight were also recorded. Soil analysis revealed a slightly acidic, loamy sand with a pH of 4.72, deficient in organic Carbon, Nitrogen, Potassium, Calcium, and Magnesium, but moderate in micronutrients like Zinc, Iron, Copper, and Manganese. Fertilizer applications of N and K significantly improved plant growth and yield. The combination of 80 kg N+80 kg K/ha produced the best results and is recommended for cassava cultivation in Igbodo. However, a decline in soil organic carbon post-harvest suggests that organic amendments (such as application of manure) should complement mineral fertilizers to enhance soil quality.

Keywords: Nitrogen, Potassium, fertilization, soil nutrient, cassava growth and yield

Introduction

Cassava (*Manihot esculenta* Crantz), also known as *manioc* or *yuca*, is a tropical root crop that holds significant importance as a staple food in many parts of the world, particularly in Africa, Asia, and Latin America (FAO, 2020). It is native to South America, and after being introduced to Africa in the 16th century, it has become an integral part of the continent's agricultural systems and diets. Today, cassava is one of the most widely cultivated crops in tropical and subtropical regions due to its adaptability to a wide range of environmental conditions, including drought, poor soils, and high temperatures (Thompson and Moyo, 2020). Its remarkable tolerance to these stress factors makes it a valuable crop in regions prone to environmental challenges. Cassava's have the ability to produce high yields even in low-fertility soils further enhances its popularity among smallholder farmers and large-scale agricultural producers. According to FAO (2018), cassava is a preferred crop for rural development, poverty relief and food security.The primary edible part of cassava is its starchy tuberous root, which is rich in carbohydrates, particularly starch. This starch content makes cassava a vital source of energy for millions of people worldwide. In addition to its use as a food source, cassava is also processed into a variety of products such as *garri, fufu*, cassava flour, starch, and tapioca, each of which plays a key role in the diets of many households. In Nigeria, cassava is of tremendous economic importance. It is one of the country's most cultivated crops and serves as a source of food security for millions of rural and urban households (Edewor and Atubi, 2021). Delta State, located in the Niger Delta region of Nigeria, is one of the leading producers of cassava in the country. The state climate and soil conditions are suitable for cassava cultivation, and many farmers rely on the crop as their main source of income. However, despite its widespread cultivation, cassava production in Delta State, as in many other parts of Nigeria, faces challenges related to soil fertility, pest and disease management, and poor agronomic practices (Okunsanya *et al*., 2022). Among these challenges, soil fertility is one of the most significant, as cassava requires substantial amounts of nutrients, particularly nitrogen (N), potassium (K), phosphorus (P), and magnesium (Mg), for optimal growth and productivity. The objectives of this study are:

1. To assess the effect of different nitrogen and potassium fertilizer levels on the growth parameters of cassava in Delta State.
2. To determine the optimal levels of nitrogen and potassium fertilizers that enhance cassava growth and yield.
3. To evaluate the interactions between nitrogen and potassium fertilizers and their combined effect on cassava development.
4. To find out the most effective fertilizer management practices for improving cassava productivity in the areas of study.

Materials and Methods

Experimental location

The study was carried out in Igbodo, a town located in the northern part of Delta State, Nigeria. Igbodo lies between latitude 5°45 ′N and longitude 6°30 ′E. Rainfall is typically heavy, occurring between March and October, with the peak rainfall months between June and September. The annual rainfall is generally between 2000 mm and 2500 mm. The temperature remains relatively high throughout the year (Olawoyin and Adebayo 2021). The annual temperature variation is relatively small, ranging between 3°C and 5°C, which is typical of tropical climates. The region's favorable climatic conditions make it suitable for the cultivation of various crops, including cassava, which is a major agricultural product in Igbodo and the surrounding communities.

Experimental material and design

The planting material used was the cassava variety 01/1797, while the nitrogen (N) and potassium (K) fertilizers applied in the treatments were Urea and Muriate of potash (K_2O), at the rates of 0, 40, 80 and 120kgN/ha and 0, 20, 40 and 80kgK/ha, respectively. The experiment followed a 4 × 4 factorial design, consisting of four levels of both nitrogen and potassium fertilizers, and was arranged in a Randomized Complete Block Design (RCBD). This resulted in sixteen treatment combinations, each replicated three times. The following treatment combinations were applied N_0K_0kg/ha, N_0K_{20}kg/ha, N_0K_{40}kg/ha, N_0K_{80}kg/ha, $N_{40}K_0$kg/ha, $N_{40}K_{20}$kg/ha, $N_{40}K_{40}$kg/ha, $N_{40}K_{80}$kg/ha, $N_{80}K_0$kg/ha, $N_{80}K_{20}$kg/ha, $N_{80}K_{40}$kg/ha, $N_{80}K_{80}$kg/ha, $N_{120}K_0$kg/ha, $N_{120}K_{20}$kg/ha, $N_{120}K_{40}$kg/ha and $N_{120}K_{80}$kg/ha. The soil were mixed with various levels of nutrients using urea to supply nitrogen and Muriate of potash as source of potassium at 4 weeks after planting by using side placement method.

Land preparation

The land was prepared manually, and cassava cuttings, each 25 cm in length, were planted at the onset of the rainy season on April 9th, 2023. The cuttings were spaced 1.0 meter apart both within and between rows. The size of each plot measured 5x4m (20m^2) with spacing of 1m between plots and 1.5 m between replicates, giving a plant population of 20 plants per plot (10,000 plants/ha).

There were, thus, a total of 48 plots (16 treatments with 3 replications). The experimental area was 1701m^2 (0.17 ha). Weeding was carried out manually by hoeing at 3 (WAP) and repeated at 8 (WAP) for the second operation. Subsequent weed control was by rogueing at 14 and 20 weeks after planting (WAP).

Data collection

Soil samples were collected using a soil auger from the experimental site before planting. A total of 10 representative topsoil samples, taken from a depth of 0–15 cm, were randomly gathered. At harvest, additional soil samples were obtained from each experimental plot to assess routine physicochemical properties, following the methodology outlined by Okalebo *et al*. (2002). Vegetative parameters, including plant height, number of leaves per plant, stem girth, leaf area and number of branches per plant were measured on four randomly selected plants at 2, 4, 6, 8 and 10 months after planting (MAP). At harvest, 10 months after planting, fresh tuber weight, fresh peeled weight, and dry matter content were recorded. The dry matter percentage (DM %) of the tubers was calculated accordingly.

Growth Parameters:

The following growth parameters were assessed at different stages:

1. Plant Height: Plant height was measured at 2, 4, 6, 8, and 10 months after planting (MAP). A tape measure was used to record the height of the plant from the soil surface to the tip of the main branch. The average height was then recorded.
2. Leaf Area: Leaf area was determined by measuring the length and breadth of selected leaves from four marked plants per plot, specifically from the middle leaves. These measurements were multiplied by a constant (6.11), as adopted from Lutaladio (1986).

3. Stem Girth: The stem girth was measured using a string wrapped around the plant at the first node, then the string was laid flat on a ruler to determine the girth.
4. Number of Branches: The total number of branches per plant was counted at 2, 4, 6, 8, and 10 months after planting.
5. Number of Leaves per Plant: The number of leaves per plant was counted at 2, 4, 6, 8, and 10 months after planting.
6. Fresh Tuber Weight: Four mature, tagged cassava plants from the central rows (net plot) of each plot were selected for harvesting and weighed.
7. Fresh Peel Weight: Four tagged cassava plants per plot were harvested, peeled, and weighed separately.
8. Dry Matter Yield of Tuber: The dry matter content of the cassava tubers was determined by drying the tubers to a constant weight in a forced-air oven at 80°C for 48 hours. Weights were measured using a top-loading balance. The dry matter percentage of both the tubers and the peels was calculated using the formula:

$$\text{Dry Matter \%} = \frac{\text{Dry Weight} \times 100}{\text{Fresh Weight}}$$

Statistical Analysis
The collected data were analyzed using Analysis of Variance (ANOVA) with the GENSTAT (2008) Software, and mean values were separated using the Least Significant Difference (LSD) test at a 5% level of probability.

Results
Physical properties of the soil
The soil in Igbodo, Delta State, where the cassava study was carried out, is mostly sandy with very little clay or silt, giving it a *loamy sand* texture. This kind of soil drains water well but doesn't hold nutrients very effectively. The soil is slightly acidic, which is good for growing cassava. However, the amount of organic matter and nitrogen in the soil is quite low, meaning the soil may not naturally provide enough nutrients for healthy plant growth. Although phosphorus levels are fair, potassium is also low, which supports the need to test how potassium fertilizer affects cassava. The soil has a decent ability to hold and exchange nutrients, with magnesium being fairly high and calcium moderate. Overall, the results show that adding nitrogen and potassium fertilizers could help improve cassava growth in this area due to the soil's limited natural fertility (Table 1).

Effect of Nitrogen and Potassium fertilizer on plant height
Table 2 shows how different levels of nitrogen and potassium fertilizers affected the height of cassava plants at various stages after planting (2, 4, 6, 8, and 10 months). Early in the growth (2 and 4 months), there were no significant differences in plant height among the treatments, suggesting that fertilizer application had little effect during the initial stages.

Table 1: Physical properties of the soil before planting

Parameters	Value
Particle size (g/kg)	
Sand	890
Silt	80
Clay	30
Textural class	Loamy sand
pH (1:1) H_20	6.0
Conductivity (uscm^{-1})	31.30
Organic carbon (gkg-^{1})	2.14
Total N (gkg^{-1})	0.13
Available P (mgkg^{-1})	11.30

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Exchangeable bases ($cmolkg^{-1}$)	
Ca	2.16
Mg	6.32
K	0.14
Na	0.30
Total exchange acidity ($cmolkg^{-1}$)	0.19
ECEC ($cmolkg^{-1}$)	8.33
Base saturation (%)	70.20

However, by 6 months after planting (MAP), plants receiving higher potassium (especially 80 kg/ha) along with moderate to high nitrogen showed noticeably greater heights, with statistical significance (as indicated by differing letters like "a" and "b" in the means). This trend continued at 8 and 10 MAP, where the tallest plants were generally found in plots treated with the highest potassium level (80 kg/ha), particularly when combined with moderate to high nitrogen. Significant increases in height were especially evident at these later stages, indicating that the effect of fertilizer on cassava becomes more pronounced as the crop matures. Overall, plant height responded better to potassium than nitrogen, with potassium at 80 kg/ha consistently producing taller plants across most sampling times.

Table 2: Effect of nitrogen and potassium fertilizer on plant height

TREATMENTS	Potassium(Kg/ha)				
Nitrogen (Kg/ha)	0	20	40	80	Mean
2MAP					
0	23.2	28.2	26.5	25.2	25.8 ns
40	21.5	20.5	24.7	23.7	22.6
80	22.2	21.5	29.2	26.8	24.9
120	25.0	25.0	22.0	31.5	25.9
Mean	23.0 ns	23.8	25.6	26.8	
4MAP					
0	83.3	92.2	81.8	89.7	86.8 ns
40	59.8	67.5	78.7	95.0	75.3
80	91.3	71.0	105.2	96.3	91.0
120	102.7	88.7	69.2	97.7	89.5
Mean	84.3 ns	79.3	83.7	94.7	
6MAP					
0	117.8	117.0	146.5	141.7	130.8a
40	100.2	108.3	113.2	121.0	110.7a
80	117.7	116.3	135.3	163.8	133.3a
120	118.0	113.3	120.7	144.5	124.1ab
Mean	113.4b	113.8b	128.9ab	142.8a	
LSD (N = 19.9, K =19.9)					
8MAP					
0	187.7	185.8	182.3	192.7	187.1ns
40	172.3	164.8	178.3	189.0	176.1
80	158.2	177.2	180.2	223.8	184.8
120	152.7	201.2	170.7	189.3	178.5

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Mean	167.7b	182.5ab	177.9ab	198.7a	
LSD (K = 27.3, N = 42.6)					
10MAP					
0	196.7	211.2	223.7	226.0	214.4ns
40	197.1	202.0	212.3	198.3	202.4
80	173.5	192.5	254.2	254.2	203.6
120	205.8	213.1	195.2	209.2	205.8
Mean	193.3b	204.7ab	206.3ab	221.9a	
LSD (K = 22.4, N = 47.7)					

Figures in the column and row followed by the same letter(s) are not significantly different at 5% level of probability. NS = Not significant.

Effect of Nitrogen and Potassium fertilizer on number of leaves per plant

Table 3.0 presents how different levels of nitrogen and potassium fertilizers affected the number of leaves per cassava plant at various growth stages. At 2 months after planting (MAP), there were slight differences, with the highest leaf count observed at 40 kg/ha of potassium. This trend showed some statistical significance across potassium levels, though not for nitrogen, suggesting early leaf development was slightly influenced by potassium application. From 4 to 10 MAP, the number of leaves generally increased, but the effects of fertilizer were inconsistent across treatments and stages. While there were no significant differences at 4, 6, and 8 MAP, a clearer pattern emerged at 10 MAP. Here, plants treated with 120 kg/ha of nitrogen had the highest leaf counts, indicating that higher nitrogen levels may enhance leaf production at later stages. Overall, potassium had a modest influence on leaf number, and nitrogen effects became more noticeable as the crop matured, especially at the final sampling point.

Effect of Nitrogen and Potassium fertilizer on stem girth (cm)

Table 4 shows the effect of nitrogen and potassium fertilizers on cassava stem girth varied across growth stages, with no significant differences observed at 2MAP, indicating limited early response to nutrient application. At 4 and 6MAP, nitrogen had a significant impact, with both low and high nitrogen rates enhancing stem girth compared to intermediate levels. Potassium influence became more pronounced from 8MAP onwards, where higher potassium rates (80 kg/ha) led to increased stem girth, suggesting its growing importance in later developmental stages. However, by 10MAP, no significant differences were observed for either nutrient, indicating that stem girth tends to stabilize as the crop matures. Overall, the results highlight a stage-specific nutrient response, where nitrogen is more influential during early to mid-growth, while potassium becomes more beneficial in later stages.

Effect of Nitrogen and Potassium fertilizer on leaf area (cm^2)

As shown in table 5, leaf area response to nitrogen and potassium fertilizers varied across growth stages, showing no significant differences at 2, 6, and 8 MAP, indicating minimal early or mid-season influence of fertilizer on foliage expansion. However, significant differences emerged at 4 and 10 MAP. At 4 MAP, the control (0 kg N/ha) produced the largest leaf area, suggesting that excessive nitrogen may suppress leaf development at this stage, while higher potassium levels tended to support increased leaf area. By 10 MAP, plants without nitrogen again had the largest leaf area, with significant differences among treatments, showing that nitrogen application beyond a certain point may not sustain or enhance foliage growth in the later stages. Potassium, particularly at 80 kg/ha, appeared to positively influence leaf area at 10 MAP, implying a potential role in maintaining foliage towards the end of the growing season. Overall, cassava leaf area responded more significantly to nutrient treatments at specific growth stages, with nitrogen showing a diminishing effect over time, while potassium's influence became more relevant later in the crop development.

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Table 3: Effect of Nitrogen and Potassium fertilizer on number of leaves per plant

Treatments	Potassium (Kg/ha)				
Nitrogen (Kg/ha)	0	20	40	80	Mean
2MAP					
0	15.5	13.8	15.7	15.7	15.1ns
40	13.8	12.3	15.5	13.5	13.8
80	12.5	11.8	15.8	13.2	13.3
120	12.8	13.2	12.7	16.2	13.7
Mean	13.7ab	12.9b	14.9a	14.6ab	
LSD (K = 2.0)					
4MAP					
0	31.7	28.7	34.5	29.0	31.0
40	28.7	29.5	26.0	37.7	30.5
80	27.2	23.3	34.2	28.5	28.3
120	46.7	38.7	26.8	29.7	35.5
Mean	33.5ns	30.0	30.4	31.2	
6MAP					
0	32.3	23.0	24.8	29.3	27.4ns
40	21.3	27.5	21.3	20.7	22.7
80	20.2	21.2	23.7	31.3	24.1
120	19.7	30.7	30.3	25.5	26.5
Mean	23.4ns	25.6	25.0	26.7	
8MAP					
0	28.2	28.8	36.2	31.7	31.2ns
40	26.7	38.5	31.7	29.3	31.5
80	28.0	26.8	40.0	40.2	33.8
120	57.5	37.0	39.2	33.8	41.9
Mean	35.1ns	32.8	36.8	33.8	
LSD (N = 7.7)					
10MAP					
0	39.8	25.8	24.8	31.5	30.5ab
40	25.0	26.5	22.8	20.7	23.8b
80	18.5	21.5	24.3	45.0	27.3ab
120	46.2	34.2	34.0	24.3	34.7a
Mean	32.4ns	27.0	26.5	30.4	
LSD (N=10.4)					

Figures in the column and row followed by the same letter(s) are not significantly different at 5% level of probability. NS = Not significant.

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Table 4.0: Effect of Nitrogen and Potassium fertilizer on stem girth (cm)

Treatments	Potassium (Kg/ha)			
Nitrogen (Kg/ha)	0	20	40	80	Mean
2MAP					
0	3.4	3.8	3.6	3.2	3.5ns
40	3.7	3.3	3.4	3.3	3.4
80	3.4	3.2	3.8	3.5	3.5
120	3.5	3.6	3.0	3.7	3.4
Mean	3.5ns	3.5	3.5	3.4	
4MAP					
0	5.5	5.5	5.9	5.5	5.6a
40	5.2	5.3	5.2	4.9	5.2ab
80	5.0	4.9	5.3	5.6	5.2ab
120	5.5	5.2	4.8	5.5	5.2ab
Mean	5.3a	5.2a	5.3	5.4a	
LSD (N = 0.43)					
6MAP					
0	6.2	5.7	6.4	6.2	6.1a
40	5.8	5.7	5.4	5.4	5.6b
80	5.4	5.8	5.7	6.3	5.8ab
120	6.0	6.0	6.3	6.0	6.1a
Mean	5.8a	5.8a	6.0a	6.0a	
LSD (N = 0.45)					
8MAP					
0	6.5	6.7	6.3	6.7	6.6ns
40	6.1	6.3	6.2	6.7	6.3
80	5.9	6.3	6.2	7.1	6.4
120	5.9	6.5	6.8	6.6	6.4
Mean	6.1b	6.5ab	6.4ab	6.8a	
LSD (K = 0.60, N = 1.2)					
10MAP					
0	7.3	6.5	6.8	7.0	6.9ns
40	6.3	6.8	6.8	7.0	6.7
80	6.0	7.0	6.5	7.8	6.8
120	7.2	7.0	7.3	6.7	7.0
Mean	6.7ns	6.8	6.9	7.1	
LSD (N =1.2)					

Figures in the column and row followed by the same letter are not significantly different at 5% level of probability. NS = Not significant.

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Table 5.0: Effect of Nitrogen and Potassium fertilizer on leaf area (cm^2)

Treatments	Potassium (Kg/ha)				
Nitrogen (Kg/ha)	0	20	40	80	Mean
2MAP					
0	325.4	356.8	414.2	316.7	353.3ns
40	378.5	301.3	349.0	301.3	332.5
80	349.3	270.4	343.0	371.0	333.4
120	373.1	387.4	311.3	385.2	364.3
Mean	356.6ns	329.0	354.4	343.6	
4MAP					
0	521.5	529.9	560.1	550.5	540.5a
40	440.3	498.6	461.1	389.2	447.3b
80	384.7	409.4	466.0	566.8	456.7b
120	434.8	419.0	435.1	512.4	450.4a
Mean	445.3ns	464.3	480.6	504.7	
LSD (N = 80.8)					
6MAP					
0	402.3	409.7	443.8	450.5	426.6ns
40	397.4	375.9	386.8	356.5	379.1
80	341.9	450.7	463.4	503.6	439.9
120	426.5	424.9	382.2	366.0	399.9
Mean	392.0ns	415.3	419.0	419.1	
LSD (N = 105.4)					
8MAP					
0	417.2	485.7	381.4	422.1	426.6ns
40	390.2	340.1	413.0	420.1	390.9
80	360.0	384.8	376.8	386.4	377.0
120	299.9	350.3	410.4	392.5	363.3
Mean	366.8ns	390.2	395.4	405.3	
10MAP					
0	488.3	470.1	446.3	488.3	473.2a
40	327.2	428.2	383.9	383.5	380.7b
80	378.1	351.3	422.2	469.6	405.3ab
120	419.1	405.3	327.1	396.8	387.1ab
Mean	403.2ns	413.7	394.9	434.5	
LSD (N = 91.9, K = 64.0)					

Figures in the column and row followed by the same letter are not significantly different at 5% level of probability. NS = Not significant.

Effect of Nitrogen and Potassium fertilizer on number of branches per plant

As shown in table 6.0, the number of branches per cassava plant showed variable response to nitrogen and potassium application across growth stages. At 4 MAP, nitrogen had a significant effect, with the highest nitrogen rate (120 kg/ha) producing significantly more branches compared to the control, suggesting early stimulation of branching by nitrogen. Potassium effects were not significant, and no consistent trend was observed across its levels. From 6 MAP to 10 MAP, differences in branching were not statistically significant, although higher nitrogen rates generally maintained greater branch numbers, particularly at 120 kg/ha, which consistently had the highest average across stages. Potassium influence remained inconsistent throughout, with no clear pattern in branch development. Overall, nitrogen appeared to impact early branching significantly, but its effect diminished as the plants matured, while potassium had minimal influence on branch number across all stages.

Effect of Nitrogen and Potassium on cassava yield

The effect of nitrogen and potassium fertilizers on cassava yield in Igbodo, Delta State, showed significant variation across several yield parameters as shown in table 7.0. Fresh and dry tuber weights were significantly influenced by both nutrients, with the highest yields observed at 80 and 120 kg N/ha, particularly when combined with moderate to high potassium levels. Notably, 80 kg N/ha paired with 80 kg K/ha produced the highest fresh tuber weight, indicating a strong positive interaction at that level. For dry tuber weight, similar trends were observed, with optimal results at 80 and 120 kg N/ha, highlighting nitrogen’s key role in storage root development. Fresh and dry peel weights also responded positively to higher nitrogen rates, especially at 120 kg N/ha, while potassium showed a more variable effect. Dry peel weight was significantly higher at 80 kg N/ha, regardless of potassium level, although the differences among potassium rates were not significant. Dry matter content, on the other hand, was not significantly affected by either nutrient, suggesting that while fertilizers improved total yield, they did not consistently alter the proportion of dry matter in the tubers. Overall, nitrogen, especially at moderate to high levels, had a more consistent and significant effect on cassava yield components than potassium, which showed selective influence depending on the yield parameter.

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Table 6.0: Effect of Nitrogen and Potassium fertilizer on number of branches

Treatments	Potassium (Kg/ha)				
Nitrogen (Kg/ha)	0	20	40	80	Mean
4MAP					
0	0.7	0.7	0.8	0.3	0.6b
40	0.5	1.3	0.5	2.3	1.2ab
80	2.0	0.0	1.8	0.5	1.1ab
120	3.0	3.0	0.3	1.3	1.9a
Mean	1.5ns	1.3	0.9	1.1	
LSD (N = 1.1)					
6MAP					
0	1.0	0.7	1.8	2.0	1.4ns
40	0.5	1.7	0.8	3.0	1.5
80	2.3	0.0	1.8	1.0	1.3
120	3.7	2.3	1.7	2.3	2.5
Mean	1.9ns	1.2	1.5	2.1	
8MAP					
0	1.7	2.3	1.8	2.0	2.0ns
40	1.5	2.7	1.8	3.0	2.3
80	1.7	0.0	3.3	1.7	1.7
120	4.0	2.7	2.8	2.7	3.0
Mean	2.2ns	1.9	2.5	2.3	
10MAP					
0	2.0	2.3	1.8	2.3	2.1ns
40	2.2	2.7	3.2	2.3	2.6
80	1.0	0.3	3.3	2.7	1.8
120	4.0	2.5	3.7	2.7	3.2
Mean	2.3ns	2.0	3.0	2.5	

Figures in the column and row followed by the same letter are not significantly different at 5% level of probability. NS = Not significant.

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Table 7.0: Effect of Nitrogen and Potassium on yield of a variety of cassava

TREATMENTS	Potassium (kg/ha)				
Nitrogen (kg/ha)	0	20	40	80	Mean
Fresh tuber weight (t/ha)					
0	3.0	4.0	4.1	3.7	3.7ab
40	2.8	2.5	4.1	3.1	3.1b
80	3.5	2.8	4.3	5.8	4.1a
120	5.9	2.6	3.7	3.5	3.9a
Mean	3.8a	3.0b	4.1a	4.0a	
Dry tuber weight (t/ha)					
0	1.2	1.8	1.3	1.5	1.5ab
40	1.0	1.1	1.8	1.3	1.3b
80	1.5	1.2	1.9	1.8	1.6a
120	2.2	1.2	1.6	1.6	1.6a
Mean	1.5ab	1.3b	1.7a	1.6a	
Fresh peel weight (t/ha)					
0	1.5	1.5	1.3	1.2	1.3ab
40	1.0	0.9	1.7	1.1	1.2b
80	1.2	0.8	1.4	2.0	1.3ab
120	1.7	1.3	1.4	1.7	1.5a
Mean	1.3ab	1.1b	1.4ab	1.5a	
Dry peel weight (t/ha)					
0	0.3	0.6	0.4	0.4	0.4b
40	0.3	0.4	0.5	0.4	0.4b
80	0.6	0.6	0.6	0.5	0.6a
120	0.7	0.3	0.4	0.5	0.5a
Mean	0.5ns	0.5	0.5	0.4	
Dry matter %					
0	41.8	44.4	30.4	42.5	39.8ns
40	38.0	42.6	44.9	41.9	41.9
80	42.5	43.9	45.7	30.6	40.7
120	39.8	45.6	44.7	45.6	43.9
Mean	40.5ns	44.1	41.4	40.2	

Figures in the column and row followed by the same letter are not significantly different at 5% level of probability. NS = Not significant.

Discussion

The study highlights the significant impact of nitrogen and potassium fertilizers on cassava growth and yield in Igbodo, derived savanna zone of Delta State, where the soil is sandy, low in organic matter, and deficient in essential nutrients. These conditions justify the need for fertilizer application, which showed varying effects depending on crop stage and nutrient applied. Early in the season, fertilizer influence on plant height and leaf production was minimal, likely due to slow nutrient uptake. However, from six months onward, potassium at 80 kg/ha, especially when combined with moderate to high nitrogen, significantly improved plant height and stem girth. This suggests potassium plays a more important role in later vegetative growth by supporting structural development and water regulation. Similar observations were reported by Ezui, Franke, Leffelaar and Giller (2017) in West Africa, where potassium strongly enhanced cassava stem robustness and canopy maintenance during later growth stages.

Nitrogen consistently influenced early traits such as leaf number and branching, with 120 kg/ha producing the highest values at 10 months after planting. However, excess nitrogen sometimes reduced leaf area, particularly at 4MAP, possibly due to excessive vegetative growth. Potassium had a subtler effect on leaf traits but improved leaf area in the later stages, especially at 80 kg/ha. These results indicate that nitrogen is more critical in the early to mid-growth stages, while potassium becomes more beneficial as cassava matures. However, in a study conducted in coastal Mozambique, applying 60 kg/ha of N alone resulted in lower tuber yields (8.5 tons/ha) compared to the unfertilized control (14.7 tons/ha). Adding K did not improve yields, suggesting that in this context, K was not a limiting factor for cassava production. A similar site-specific effect was noted by Nyakuni, *et al* (2019) in Uganda, who reported that cassava response to nitrogen and potassium varied strongly with soil fertility status, highlighting the need for location-specific fertilizer recommendations.

For yield, nitrogen had a stronger and more consistent effect than potassium. Fresh and dry tuber weights increased significantly with 80 and 120 kg N/ha, especially when combined with potassium. The best yield was recorded with 80 kg N/ha and 80 kg K/ha, showing a positive nutrient interaction. Dry tuber weight followed the same trend, emphasizing nitrogen's importance in root development. This aligns with the observation made from a study by Sinta and Dansa (2023) that nitrogen plays a critical role in cassava yield. Fresh and dry peel weights also improved under high nitrogen levels, though potassium's influence was inconsistent. Dry matter content remained unaffected by either nutrient, indicating that while fertilizers improved total yield, they did not change tuber composition. In Nigeria, Lawal, *et al* (2020) also found that cassava tuber yield increased significantly with combined nitrogen and potassium application, though the response plateaued beyond moderate fertilizer levels. Similarly, Ayoola, *et al* (2017) reported that balanced N and K fertilization enhanced cassava tuber bulking and nutrient use efficiency in the derived savanna zone.

The study has limitations. Conducted in a single location with a specific soil type, the results may not apply to other regions. Environmental factors such as rainfall and temperature were not tracked, and the long-term impact of fertilizer use on soil health wasn't assessed. Economic feasibility was also not evaluated, which is essential for real-world application. These limitations suggest a need for broader, longer-term research to determine optimal and sustainable nutrient management strategies for cassava.

Conclusion

In conclusion, the study demonstrates that nitrogen and potassium fertilizers significantly influence cassava growth and yield in sandy, nutrient-deficient soils like those in Igbodo, in derived savanna zone of Delta State, with nitrogen showing stronger effects during early growth stages and potassium becoming more impactful as the crop matures. The combination of 80 kg N/ha and 80 kg K/ha produced the highest yields, highlighting the importance of balanced nutrient application.

However, results from other regions, such as coastal Mozambique, suggest that fertilizer responses are site-specific and influenced by local soil and environmental conditions. Therefore, it is recommended that fertilizer application for cassava be tailored to local soil characteristics, and further multi-location, long-term studies should be conducted to refine nutrient management strategies. Additionally, assessing the economic viability and environmental sustainability of fertilizer use will be critical for widespread, practical adoption.

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