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Effects of Inorganic Fertilizer and Lime Rate on Chemical Properties of Soil and Yeild of Cassava (Manihot Esculenta Crantz) in Obio Akpa, Akwa Ibom State.

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ABSTRACT

Field experiment was carried out at Teaching and Research Farm of Akwa Ibom State University Obio Akpa in August 2021 to evaluate effects of inorganic fertilizer and lime rate on chemical properties of soil and yield of cassava (Manihot esculenta Crantz). The experiments were laid out in a randomized complete block design replicated thrice in 3×3 factorial. Factor A treatments were three NPK fertilizer rates (0, 200, 300 kg/ha) while Factor B treatments were three liming rates (0, 100 and 200 kg/ha). Growth and yield parameters were assessed. Data obtained were subjected to analysis of variance significant means were compared using least significant difference at 5% probability level. Results showed significant increase in growth and yield parameters with increase NPK fertilizer rate. Comparing the effect of NPK rates in field and yield component parameters, the application of 300kg/ha NPK, produced significant higher number of tubers per plant; 7.48 while the least; 3.08 was recorded from control. The application of 100kg/ha lime produced significant tuber yield of 31.07t/ha, followed by 27.11t/ha recorded in 200kg/ha lime rate. The least tuber yield, 20.64t/ha was recorded in control (no lime application). The treatment interaction between NPK fertilizer and liming rates on tuber yield varied significantly. The interaction of 300kg/ha NPK and 100kg/ha lime produced significant tuber yield of 38.90t/ha, while the least, 9.04t/ha was recording in treatment interaction of no fertilizer and no lime application.

Keywords: Inorganic fertilizer, lime rate, chemical properties, soil, cassava yield.

Introduction: Low soil fertility status is a major constraint in cultivating cassava in Akwa Ibom State, South-South Nigeria. Udounang, P. I., Essien, O. A., Umoh, F. O., Ijah, C. J. and Akpainyang, F. E. (2023) pointed out that low fertility is caused by the continuous cultivation of land without appropriate soil management practices and the nature of the parent material, impact of raindrop on aggregate (Essien, O. A., Sam, I.J and Umoh, F.O. 2019) disintegration of soil particles due to high rainfall energy and also soil degradation mostly anthropogenic through degradative land use and management practices (Ikeh, A. O., Ndaeyo, N. U., Akpan, E. A., Udoh, E. I., & Akata, O. R. 2013).Ogban, P.I., Ibotto, M. I. Utin, U.E., Essien, O. A. and Arthur, G. J. (2022) explained that decline in soil fertility that helps in aggregation chances detachability and predisposes soil to erosion and soil loss that contributes to low soil fertility, resulting in low cassava production. Cassava (*Manihot esculenta Crantz)* is a perennial woody shrub of the family Euphorbiaceae (Ibia, T. O. and Udo, E. J. 2009). It is a root crop that is propagated vegetatively by stem, that produces storage roots (Ben, F. E., Okpara, D. A., Akpan, E. A., Udounang, P. I., Akata, O. R., & Inyang, P. 2024). The roots form large starchy tubers, with a dark brown fibrous covering the white flesh (Roger, 2014).

Cassava originated from tropical America, North Eastern Brazil and was introduced into Africa in the Congo Basin by the Portuguese around 1558 (Ikeh, A. O., Ndaeyo, N. U., Akpan, E. A., Udoh, E. I. and Akata, O. R. 2013). Cassava is a food plant brought from the new world to the Tropical Africa where it is now established (Akata, 2015). Portuguese distributed the crop from Brazil to countries like

Singapore, Malaysia, Indonesia and India (Roger, 2014). Cassava crop is a stable root crop, and has become an important crop in Nigeria and all over the world (Udounang, P. I., Ekwere, O. J., & Akata, O. R. 2021; Thomas, I. U., Ekwere, O. J., and Akpaninyang, F. E. 2023). According to Amane distributed the crop from Brazil to countries like Singapore, Malaysia, Indonesia and India. Cassava crop is a stable root crop, and has become an important crop in Nigeria and all over the world. According to Amaner (2011), the world annual production of cassava is over 158 billion tons. Akata, O. R., Akpan, E. A., & Enyong, J. K. (2016) also confirmed that amount is used for various uses including human consumption (58%), animal feed (22%), and other uses (20%). Cassava is the primary source of Carbohydrates (mainly Starch) and minerals (Enyong, J. F., Ndaeyo, N. U., Ndon, B. A., Ugbe, L. A., and Akpan, E. A. 2013; Ekwere, O. J., Udounang, P. I., and Akpaninyang, F. E. 2023).The root of the cassava plant Contains Significant amounts of nutrients, including Calcium and Vitamin C and a lot of minerals Salts, while the leaves have been found to contain protein, carotene and lysine (Graham, R. D., Welch, R. M., Bonis, H. E. 2001; Akata, O. R., Uko, A.E., Nwagwu, F.A., Ndaeyo, N. U., Ikeh, A.O., and Essang, D.M. 2016). It is cultivated both as food for human and animals, also as industrial raw material (Akata *et al.*, 2016; Ekwere, O. J., Akpan, E. A., & Akata, O. R. 2019).

The most important industrial utilization of cassava is ethanol, Starch, biofuel, flour, biscuits, bread, jelly, thickening agents, gravies custard powder, babies' foods, glucose and confectionaries (Uwah, D. F., Effia, E. B., Ekpeyong L. E., and Akpan, I. E. 2009). In many countries, significant research has begun to evaluate the use of cassava as an ethanol biofuel feed-stock (Graham, R. D., Welch, R.M., Bonis, H.E. 2001; Maurice, B. P., & Akata, O. 2022) The bitter variety leaves are used to treat hypertension, headache and pain. As cassava is a gluten free natural starch, it's used in Western Cuisine as wheat alternative for sufferers of celiac disease (Udounang, P. I., Ekwere, O. J., & Akata, O. R. 2022). Lime are materials containing carbonates, oxides or hydroxide required to apply on acidic soil to raise soil pH and neutralizes toxic elements in the soil (Umoh, F. O., Osodeke, V. E., & Akata, O. R. 2017; Howeler 1996). Concentrations, it dissociates into Ca^{2+} on OH^- ions. The hydroxyl will react with hydrogen and Al^{3+} ion forming Al^{3+} hydroxide and water; thereby increase soil pH in the soil solution.According to Uwah *et al.*, (2009) plant height, the number of leaves, branches as well as stem girth were significantly increased by the application of NPK. Various research finding showed superior growth attributes obtained with relatively high rates of NPK (NRCRI, 2005). Since low inherent soil fertility status has been reported for most soils of South-South Nigeria, which are typically ultisols and this constitutes a major constraint to cassava production. Inorganic fertilizer can be used to horate soil with low nutrient status for sustainable intensive cropping, because it is often associated with reduced crop yield, increase acidity, leaching and nutrient imbalance (Ikeh, A. O., Ndaeyo, N.U., Akpan, E. A., Udoh, E.I and Akata, O. R (2013). Also, when cassava root yields are high and crop residues are not ploughed back into the soil, cassava harvest removes large quantities of nitrogen and potassium. To sustain yields and soil fertility, cassava would require per hectare annual applications estimated between 50 to 100 kg of nitrogen, 65 to 80 kg of potassium and 10 to 20 kg of phosphorus, depending on inherent soil fertility and yield levels desired (FAO, 2013). Seeing this growing interest over the crops there is need to determine a recommended NPK inorganic fertilizer and lime application rates under cassava through this study to maximize its production in the country and boost the effort of foods security at large. This study therefore aims at examining effect of inorganic fertilizer and lime at various rates on soil properties and yield of cassava.

Material and Methods: Experimental Site and Cropping History The study was conducted at the University Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus in Oruk Anam Local Government Area, Akwa Ibom State on University 2021. It lies between latitude $4^0$30S and $5^0$30N and longitude $7^0$30 W and 8^0 00E (Slus, A. K., 1989). Mean annual rainfall ranges from 2000mm and 2600mm with bimodal pattern, which peaks in June and October (Slus, A. K., 1989), usually with a break in August (termed August break) which last for about two weeks. The crops that were grown on this location were Yam. Potatoes, Melon, Maize, Fluted Pumpkin, etc.

Experimental Design and Treatment

The experiment was a 3x3 factorial randomized complete block design with three

(3) replications and 9 treatment combinations per replicate. The Treatment used were

1. L101 2. L102 3. L103 4. L201 5. L202 6. L203 7. L301 8. L302 9. L303

With cassava variety TMS 419

Experiment Plot Size

The plot size was 46m × 22m (1,012 m^2) and the plots were divided into three replicates with nine (9) treatments each 6m × 4m. The plot border line and replication were separated by a path of 1.0 each respectively.

A-F = Treatments

* R1-R3 = Blocks or replicates

Agronomic Practices

Land Preparation: The land was slashed with machete; debris were packed with hand and mounds were made at a spacing of 1m apart.

Planting: Planting was done with healthy cuttings of 20cm long planted at a spacing of 1m × 1m. Total number of cuttings was 648. Cuttings per each replication was 216.

Field Management Practices

Weed Control Hoe – weeding was done at 2 months after planting, subsequently, two other weeding were carried out at 5 and 10 months after planting.

Fertilizer Application
Inorganic fertilizer NPK (15:15:15) was applied at 4 weeks after planting while the lime was incorporated into the soil 14 days before planting.

Data Collected
The following growth and yield parameters were collected;

(A). Growth Parameters:
Establishment Percentage (%): Sprouting percentage was taken at 1 month after planting.

(ii.) Cassava Height (cm): Plant height was measured at 2, 4, 6, 8 and 10 months after planting. Measurements were taken from the soil level to the terminal end of each of the tagged plants using a pole graduated in centimeter. **Leaf Area (cm^2):** Leaf spread was measured at two months interval from 2 – 10 months after planting. Measurement were taken using a long pole at the two furthest ends of each tagged plant and the average value taken and was multiplied with the correction factor 0.7.

(iii). Cassava Height at First Branching (cm): The height at first branching was taken two months after planting.

(iv).Number of Branches per Plant: Number of branches per plant was counted at 2, 4, 6, 8 and 10 months after planting.

Number of Leaves per Plant: This was obtained by counting the number of leaves per plant.

(B). Yield Parameters

(i). Number of Stands per Hectare at Harvest: All the cassava surviving stands per plot at harvest were counted and were converted to hectare.

Number of Fresh Tubers per Plant: The total number of fresh tubers per plant was determined by counting the number of tubers per plant.

(ii). Tuber Length (cm): The length of tubers was measured from the proximal to distal end using a flexible measuring tape.

(iii). Number of Marketable Tubers: This include all cassava tubers weighing more than 300g and above.

(iv).Number of Unmarketable tubers: This include all cassava tubers weighing less than 300g, based on IITA standard specification.

(v). Tuber Circumference (cm): This was done by measuring the girth of 5 selected tubers at the middle of each tuber at the middle of each tuber selected before finding the mean.

(vi). Number of Rotten Tubers: All rotten tubers per plot was taken by counting.

(vii). Foliage Yield (kg) Per Stand: Weight of top growth of cassava stand was determined using a spring scale balance at harvest.

(viii). Tuber Yield per Hectare: Tuber yield per hectare was determined by the use of weighing scale, and the weight per plot was converted to tones per hectare.

Data Analysis

Data collected were subjected to analysis of variance procedure and treatment means that indicated significant differences at 5 percent level of probability were compared using least significant differences.

Results and Discussion: Soil Analysis: The initial and post harvest analysis of the experiment site is sown in (Table 4.1). at the beginning of the experiment the soil was dominated by high sand fraction of 71.92, after application of lime and NPK rates the sand fraction reduction was up to 69.92%. This high fraction of sand was not good for root crop like cassava as pant lodging will result in exposure of cassava roots to pests and subsequent yield reduction.

The pH of the soil varied between 5.6 to 5.10 at the beginning and end of experiment, within this range moderate lime was required for optimum cassava growth which functions within the range of 4.5 to 6.5 for proper growth and tuber production (Ibia and Udo, 2009).

action on liter possibly caused by fertilizer and lime application.

Nitrogen content in the soil was 0.11% at the beginning of the experiment and dropped up to 0.03% at the end of experiment. This reduction could have been caused by high demand of nitrogen by cassava as a root crop for growth and tuber formation.The concentration of basic cations (Ca, Mg, K, Na) were applied as crop cassava has high demand of these nutrients for growth.In view of the low nutrient status of the study site, the need for applying different rates of NPK and lime was eminent in improving the nutrient content of the site for increased cassava growth and yield.

Table 1: Pre and Post – Planting Physico-Chemical Properties of the Soil

Parameter	Soil Before	Soil After

Depth (cm)	0 – 15	0 – 15
Sand (%)	71.92	69.92
Clay (%)	22.24	24.30
Silt (%)	5.84	5.78
pH(H_2O) (1:2)	5.10	5.6
Electrical Conductivity (ds/m)	0.08	0.1
Total Nitrogen (%)	0.11	0.03
Available P (mg/Kg)	87.55	36.68
Organic Carbon (%)	1.42	0.88
Ca (Cmol/Kg)	3.01	3.84
Mg (Cmol/Kg)	1.59	2.68
K (Cmol/Kg)	0.11	0.11
Na (Cmol/Kg)	0.07	0.15
Exchangeable Bases (Cmol/Kg)	0.1	0.1
Al^+ (Cmol/Kg)	1.06	1.46
ECEC (Cmol/Kg)	1.95	10.62
Exchange Acidity (Cmol/Kg)	1.95	3.84
Bases Saturation	73.30	63.8
Textural Class		LS

Establishment Percentage ad Cassava Plant Height (cm) as Influenced by NPK Fertilizer and Lime Rates

Establishment percentage of cassava as influenced by NPK fertilizer rates showed no significant difference (P<0.05) among the fertilizer treatments (Table 4.2). the establishment percentage recorded was 100% in control, 200 and 300kgtha rates, respectively comparing the effect of lime rates on cassava establishment percentage, the result showed no significant difference (P<0.05) (table 4.2). The range of establishment percentage recorded in lime treatments was 95%-100%. The interaction effect between fertilizer rates and lime rates indicated no significant differences (P<0.05)(Table 4.2).. Cassava height as influenced by fertilizer rates varied significantly (P<0.05) Table 4. The taller plant, 148.16, 193.10, 269.01 and 390.8 cm at 4,6,8 and 10 months after planting (MAP) was recorded in the treatment of 300kg/ha. This is followed by 131.40, 167.50, 240.60 cm plant height recorded in the treatment of 00 kg/ha, NKP rate at 4.6.8 and 10 MAP, respectively. The shortest plant 101.30, 129.70, 150.11 and 162.14 cm at 10 MAP respectively was recorded in control treatments.

Effect of lime rates on plant height showed significant difference (p<0.05) at 4,6,8 and 10 MAP (Table 4.2) and at 4 MAP the result showed no significant difference (p<0.05) between mean, height of 142.13cm and 144.50cm recorded in 200kg/ha NPK and 300kg/ha NPK rates, but significant when compared to the mean height of 98.17cm recorded in control treatment. At 6, 8 and 10 MAP, the result revealed that the treatment of 200kg/ha lime had significant taller plants, 210.21, 263.36 and 274.83cm, respectively. This was followed by corresponding plant height of 187.33, 210.50 and 23.16cm, recorded in the plot that received 300kg/ha lime. The shortest plant 133.18, 169.27 and 192.56cm respectively was recorded in the control treatment. The interaction effect between fertilizer rates and lime rates on plant height only differed significantly (p<0.05) at 8 and 10 MAP.

Table 2: Establishment Percentage and Cassava Plant Height (cm) as Influenced by NPK **and Lime Rates**

Treatment	Est. (%)	Cassava Plant Height at Months after Planting				
		2	**4**	**6**	**8**	**10**
NPK (kg/ha)						
0	100	65.80	101.30	129.70	150.11	162.14
200	100	61.77	131.40	167.50	224.01	240.60
300	100	62.40	148.60	193.10	269.01	390.8
LSD(P<0.05)	NS	NS	3.07	5.51	5.90	4.80
Lime (kg/ha)						
0	100	59.17	98.17	133.18	169.27	192.56
200	95	60.30	142.13	210.21	263.36	274.83
300	100	58.33	144.50	187.33	210.00	232.16
LSD(P<0.05)	NS	NS	3.24	4.18	4.25	6.02
Interaction FXL	NS	NS	NS	NS	3.62	3.15

Not Significant **Interaction Effect between NPK fertilizer Rates and lime rates on cassava**

The interaction affect between NPK rates and lime rates on cassava height showed significant difference (p>0.05) at 8 MAP (table 4.3) significant interaction effect on plant height was recorded in the treatment of 300kg/ha NPK and 100kh/ha time 303.14cm This was followed by 208. 15cm recorded in the treatment of 200kg/ha NPK and 100kg/ha lime. The shortest plant, 136.72cm, was recorded in the treatment of control (no fertilizer) and no lime application. Table 3: Interaction between NPK Fertilizer Rates and Lime Rates on Cassava Height at **8 MAP**

NPK Rates (Kg/ha)	Lime Rates (Kg/ha) 0	100	200	Total	Mean
0	136.72	157.98	155.63	450.33	150.11
200	172.33	208.15	210.75	672.03	224.01
300	198.76	303.14	265.13	807.03	269.01
Total	507.81	790.07	631.51		
Mean	169.27	263.36	210.50		

LSD (P<0.05)	3.62

Interaction Effect between NPK Fertilizer Rates and Time Rates on Cassava Height at 10 MAP

The interaction between NPK fertilizer rates and rent rates on cassava height at 10 MAP is shown in Table 4 the result indicated significant differences when different mean values were compared. The tallest cassava, 340.94cm was recorded in interaction treatment of 300kg/ha fertilizer rate and 100kg/ha lime rate. This was followed by 300.90cm height recorded lime. The shortest plant, 140.66cm was observed in the interaction of both control treatments (no NPK application and no lime application).

Table 4: Interaction between NPK Fertilizer Rates and Lime Rates on Cassava Height at 10 MAP

NPK (kg/ha) Rates	0	100	200	Total	Mean
0	140.66	182.65	163.11	486.42	162.14
200	175.70	300.90	245.20	721.80	240.60
300	261.33	340.94	288.16	890.43	296.81
Total	577.69	824.49	696.47		
Mean	192.56	274.83	232.16		
LSD(P<0.05)		3.15			

Number of Cassava Leaves per Plant as Influences by NPK Fertilizer Rate and Lime Rate

Number of leaves per plant as influenced by NPK and lime application varied significant by different at 4, 6, 6 and 10 MAP (Table 5) number of leaves per plant gradually increased from 2 MAP and reach at peak in 8 MAP, and then declined at 10 MAP irrespective of factors and treatments (Table 5).

Among the NPK fertilizer rates the treatment of 300kg/ha produced significant higher number of leaves or plant; 90.06, 209.06, 256.01 and 221.66 at 4, 6, 8 and 10 MAP respectively. This was followed by 85.17, 160.25, 220.70 and 192.18 respectively, recorded in the treatment at 200kg/ha NPK. The least number of leaves per plants 50.62, 112.30, 132.40 and 106.31, respectively was recorded in the treatment control (no fertilizer amendment).

Table 5: Number of Leaves per Plant as Influenced by NPK and Lime Rates

Treatment NPK (kg/ha)	2	4	6	8	10
0	28.40	50.62	112.30	132.40	106.31
200	29.71	85.71	160.25	220.70	192.18
300	30.06	90.06	209.20	256.01	221.66
LSD(P<0.05)	NS	4.77	5.01	6.74	5.40
Lime (kg/ha)					
0	27.60	55.48	107.55	125.67	150.57
100	29.44	91.05	213.90	250.33	198.96

200	28.72	92.30	190.62	210.12	170.62
LSD(P<0.05)	NS	3.16	3.80	5.56	3.50
Interaction (FXL)	NS	NS	NS	2.27	NS

Number of Leaves per Plant as Influenced by Application of Lime

The result showed that the treatment of 100kg/ha lime produced significant higher number of leaves per plant from 6 to 10 MAP, (213.90, 250.33 and 198.96, respectively). (Table 5), the treatment of 200kg/ha lime produced; 190.62, 210.12 and 170.62 leaves per plant at 6, 8, and 10 MAP, respectively. The least of leaves per plant; 55.48, 107.55, 125.67 and 150.57 at 4, 6, 8 and 10 MAP, respectively was recorded in the control treatment.

The interaction effect between NPK fertilizer rates and lime rates on number of leaves per plant differed significantly only at 10 MAP (Table 6). The results showed increases in NPK rate with increase in number of leaves per plant at 100kg/ha lime application and declined at 200kg/ha lime treatment. The highest number of leaves per plant; 260.19 was at the interaction of 300kg/ha NPK and 100kg/ha lime. The least number of leaves per plant, (89.25) was recorded in control treatments (no fertilizer application and no lime application).

Table 6: Interaction between NPK Fertilizer Rates and Lime Rates on Number of Cassava Leaves per Plant at 8 MAP

Treatment NPK Rates	Lime Rates (kg/ha)				
	0	100	200	Total	Mean
(kg/ha)					
0	89.25	128.43	101.25	318.93	106.31
200	178.40	208.25	189.89	576.54	192.18
300	184.06	260.19	220.73	664.98	221.66
Total	451.71	598.87	511.87		
Mean	150.57	198.96	170.62		
LSD (P<0.05)		2.27			

Number of Branches per Plant as Influences by NPK Fertilizer Rates and Lime Rates

The result showed that application of NPK fertilizer facilitated significant increase in number of branches per plant (table 7). The result also showed increase in number of branches per plant form 2 MAP to 10 MAP. The significant higher number of branches per plant; 6.40, 11.08, 19.85 and 21.20 at 4, 6, 8 and 10 MAP, respectively was recorded in the treatment that received 300kg/ha NPK. This was followed by 5.25, 9.42, 15.90 and 16.15 branches per plant, respectively recorded in 200kg/ha NPK. The least number of branches per plant; 2.11, 5.20, 9.07 and 9.25 respectively, was recorded in control treatment. Among liming rates, the result showed significant difference (P<0.05) from 4 MAP to 10 MAP, with the treatment of 100kg/ha lime having significant higher number of branches per plant; 6.46, 12.06, 17.04 and 14.14 branches per plant, respectively recorded in the treatment of 200kg/ha lime. The least number of branches per plant; 2.81, 4.12, 7.66 and 8.17, respectively, was recorded in no lime application treatment (control).

The interaction effect between NPK fertilizer rates and lime rates on number of branches per plant at 2, 4, 6, 8, and 10 MAP, showed significant difference (Table 7).

Table 7: Number of Branches per Plant Treatment

NPK (kg/ha)	2	4	6	8	10
0	1.72	2.11	5.20	9.07	9.25
200	2.00	5.25	9.42	15.90	16.15
300	1.92	6.40	11.08	19.85	21.20
LSD((P<0.05)	NS	2.42	2.36	3.07	3.13

Lime (kg/ha)					
0	1.56	2.81	4.12	7.66	8.17
100	1.70	6.46	12.06	17.04	20.22
200	1.69	3.36	8.44	11.50	14.44
LSD((P<0.05)	NS	1.98	2.61	2.75	4.25
Interaction (FXL)	NS	NS	NS	NS	NS

NS = Not Significant

Leaf Area (cm²) of Cassava as Influenced by NPK Fertilizer Rates and Lime Rates

Leaf area of cassava as influenced by NPK fertilizer rates varied significantly in all the sampled months. The leaf area gradually increased from 2 MAP to 6 MAP and started declining from 8

MAP (Table 8) comparing the fertilizer treatments 300kg/ha NPK produced larger leaf area, 184.33, 189.26, 215.06, 210.75 and 172.39 cm² at 2, 4, 6, 8 and 10 MAP respectively. The smallest

leaf area 108.16, 112.25, 120.11, 118.76 and 105.37 cm², respectively was recorded in the control treatment (no soil amendment).

Among the liming treatments, the treatment of 100kg/ha lime, had significant larger leaf area,

188.66, 193.47, 199.72, 182.60 AND 1590.00 cm² at 2, 4, 6, 8 and 10 MAP, respectively (Table

8). The least leaf area, 126.44, 140.25, 163.51, 150.70 and 102.06 cm² at 2, 4, 6, 8 and 10 MAP, respectively was recorded in the control (no lime amendment) treatment. The interaction effect between NPK fertilizer rates and lime rates on leaf area showed significantly different (P<0.05) only at 6 MAP.

Table 8: Leaf Area (cm²) as Influenced by NPK Fertilizer Rates and Lime Rates Months after Planting

Treatment					
NPK (kg/ha)	**2**	**4**	**6**	**8**	**10**
0	108.16	112.25	120.11	118.76	105.37
200	163.40	178.46	192.77	190.81	158.06
300	184.33	189.26	215.06	210.75	172.39
LSD(P<0.05)	3.25	4.12	5.33	5.10	4.06
Lime (kg/ha)					
0	126.44	140.25	163.51	150.70	102.06
100	188.66	193.47	199.72	182.60	159.00
200	170.19	160.33	164.71	161.60	132.41
LSD(P<0.05)	2.82	3.50	4.25	3.92	4.79
Interaction FXL	NS	NS	2.01	NS	NS

Interaction Effect between NPK Fertilizer Rates and Lime Rates on Leaf Area at 6 MAP

The interaction effect between NPK fertilizer rates and lime rates on leaf area at 6 MAP is shown in (Table 9) comparing the mean values, from different interactions, the treatment

interaction of 300kg/ha NPK and 100kg/ha lime had significant higher leaf area of 233.12 cm². This was followed by 215.36 cm² recorded in the treatment interaction of 200kg/ha NPK and 100kg/ha lime rate. The smallest leaf area, 100kg/ha cm² was recorded in the treatment of no fertilizer application (control) and no lime application (control).

Interaction Effect between NPK Fertilizer Rates and Lime Rates on Leaf Area at 6 MAP Lime Rates (kg/ha)

Treatment NPK (kg/ha)	Rates 0	100	200	Total	Mean
0	100.31	150.68	109.34	360.33	120.11
200	189.40	215.36	173.55	578.31	192.77
300	200.81	233.12	211.25	645.18	215.06
Total	490.52	599.16	494.14		
Mean	163.51	199.72	164.14		
LSD(P<0.05)		2.01			

Yield and Yield Components of Cassava as Influenced by NPK Fertilizer Rates and Lime RatesNumber of Tubers per Plant: Number of tuber plant as influenced by NPK fertilizer rates showed significant difference (P<0.05) (Table 10). The treatment of 300kg/ha NPK produced significant higher number of tubers; 7.48 compared to 3.08 tubers per plant recorded in control. Number of tubers per plant ass influenced by lime application is presented (Table 10) significant higher number of tubers per plant 5.80 was recorded in the treatment of 100kg/ha. This was followed by 3.10 tubers per plant recorded in the treatment of 200kg/ha lime. The least number of tubers per plant; 2.91 was recorded in the control. The interaction effect between NPK and lime rates on number of cassava tubers per plant indicated no significant difference.

Length of Tuber: Length of tubers as influenced by NPK fertilizer is presented in (Table 10). The significant longest tuber 23.50cm was recorded in the treatment that received by 19.40cm recorded in 200kg/ha NPK. The shortest tuber; 13.30cm was recorded in control treatment. Length of tuber per plant as influenced by liming rates is shown in (Table 10). The treatment of 100kg/ha lime produced significant longer tuber of 19.50cm on average, followed by 16.25, recorded in 200kg/ha lime. The shortest 10.47cm was recorded in control treatment (no lime application).The interaction effect between NPK fertilizer rates and time rate on tuber length showed no significant (Table 10). Tuber circumference (cm) as influenced by NPK fertilizer rates varied significantly (P<0.05) with the treatment of 300kg/ha having the largest circumference; 20.13cm (Table 10). This was followed by 18.41cm recorded in the treatment of 200kg/ha NPK. The least tuber circumference; 8.22cm was recorded in the control treatment. The effect of lime application on tuber circumference also showed significant difference (P<0.05) (Table 10). The treatment of 100kg/ha lime produced bigger cassava circumference; 19.78cm, this was followed by 15.15cm recorded in the treatment of 200kg/ha. The least tuber circumference; 11.06cm was recorded in control treatment. The interaction effect between NPK fertilizer rates and lime rates shown in Table (11). The result showed significantly different (P<0.05).

Tuber Yield Tuber yield as influenced by fertilizer and lime application shown in (Table 10). Comparing the NPK fertilizer highest significant tuber yield; 33.72t/ha, (Table 10), this was followed by 29.40t/ha tuber yield recorded in the treatment of 200kg/ha NPK rate. The least tuber yield, 15.70t/ha was recorded in the control treatment. The effect of liming rates on cassava tuber yield is presented in (Table 10). The result showed that the application of 100kg/ha lime produced significant tuber yield of 31.07t/ha, followed by 27.11t/ha tuber recorded in the treatment of 200kg/ha lime. The least tuber yield; 20.64t/ha was recorded in the treatment of no lime application.The interaction effect between NPK fertilizer rates and liming rates on tuber yield also differed significantly (P<0.05) (Table 10).

Table 10: Yield and Yield Component of Cassava as Influenced by NPK Fertilizer Rates Lime Rates

NPK (kg/ha)	Number of Tubers/Plant	Length of Tuber (cm)	Circumference of Tuber (cm)	Tuber Yield (t/ha)
0	3.08	13.30	8.22	15.70
200	5.77	19.40	18.41	29.40
300	7.48	23.50	20.13	33.72
LSD(P<0.05)	1.96	2.07	3.37	4.11
Lime (kg/ha)				
0	2.91	10.47	11.06	20.64
100	5.80	19.50	19.78	31.07
200	3.70	16.25	15.57	27.11
LSD(P<0.05)	1.78	3.39	2.45	3.71
Interaction	NS	NS	2.01	2.73

Interaction Effect between NPK Fertilizer Rates and Lime Rates on Tuber Circumference

The interaction effect between NPK fertilizer rates and lime rates on tuber circumference Differed significantly (P<0.05) (Table 11). The significant largest tuber circumference; 25.01cm was recorded in the treatment of 300kg/ha NPK and 100kg/ha lime. This was followed by 22.50cm tuber circumference recorded in interaction of 300kg/ha NPK and 200kg/ha lime. The least tuber circumference; 5.48cm was recorded in interaction of no fertilizer application (control) and no lime application.

Table 11: Interaction Effect between NPK Fertilizer Rates and Lime Rates on Cassava Tuber Circumference

Treatment NPK Rates (kg/ha)	Lime Rates (kg/ha) 0	100	200	Total	Mean
0	5.48	10.04	9.12	24.66	8.22
200	15.22	22.50	17.51	55.23	18.41
300	15.48	25.01	19.90	60.39	20.13
Total	36.18	57.55	46.53		
Mean	12.06	19.18	15.51		
LSD(P<0.05)		2.01			

Interaction Effect between NPK Fertilizer Rate and Lime Rates on Cassava Tuber Yield

The Result showed significantly different (P<0.05). The significant highest tuber yield 38.90t/ha was recorded in the interaction of 300kg/ha NPK fertilizer and 100kg/ha lime rate. The interaction of 300kg/ha NPK and 100kg/ha lime rate produced 34.30t/ha tuber yield while the least tuber yield; 9.04t/ha was recorded in the treatment interaction of no fertilizer application and no lime application.

Table 12: Interaction Effect between NPK Fertilizer Rate and Lime Rates on Tuber Yield Treatment

NPK Rates (kg/ha)	Lime Rates (kg/ha) 0	100	200	Total	Mean
0	9.04	20.01	18.05	47.10	15.70

200	24.02	34.30	29.88	88.20	29.40
300	28.86	38.90	33.40	101.16	33.72
Total	61.92	93.21	81.33		
Mean	20.64	31.07	27.11		
LSD(P<0.05)		2.73			

Discussion: Soil analysis result showed that the soil of the experimental field was low in fertility level except for phosphorus. The soil was deficient in some major elements, as values recorded were below critical values. The percentage organic matter was below the critical value of 2.0% (<20g/kg) and were classified as low inorganic matter based on the recommendation of Ibia and Udo (2009). Percentage total nitrogen was low and less than 0.15% (1.5g/kg) as critical value. The soil pH level of the soil was 5.10; this showed that the soil was acidic. The low fertility and acidic nature of the soil could be due to exhaustive use of the land for over a long period without adequate soil management and conservation practices. Therefore, application of fertilizer and lime in the soil for planting cassava was justifiable.

The result showed that the application of NPK fertilizer enhanced cassava growth and yield. The growth of cassava plant in this study indicated significant increase in growth and yield parameter with increase in NPK fertilizer level. The study shows that it was appropriate that the quantity (rate) of NPK fertilizer used, which invariably influenced the adequacy of essential nutrient elements available in the soil influenced vegetative growth and yield of cassava. The significant increase in growth and yield parameters recorded in the treatment of 300kg/ha compared to no fertilizer application treatment (control) was evident that adequate nutrient level influences plant growth and productivity. It was earlier noted that the soil of the experimental site before planting was low in fertility. However, the plant growth and yield characters increased as NPK fertilizer dose increase which is attributed to greater supply of plant nutrients with incremental application of NPK fertilizer, since control was low in nutrient content, this observation is similar to the findings of Akata (2015); Udounang *et al.*, (2021).

The significant increase in growth and yield parameters in the treatments of 300kgg/ha and 200kg/ha NPK fertilizer proved that NPK fertilizer contains essential nutrient element associated with high photosynthetic activities and thus promotes vegetative growth and root development (Akata *et al.*, 2015; Thomas *et al.*, 2023). Also, this could be attributed to improved soil fertility such as higher nitrogen content which was lacking in the soil before planting. Increase in nitrogen as a result of NPK application, caused have enhanced physiological activities in the crop, thereby improving the synthesis of Photo – assimilated (Akata *et al.*, 2016). Application of lime promotes growth and yield of cassava from the study finding. The treatment of 100kg/ha enhanced higher growth and yield of cassava compared to the treatment of 200kg/ha and the control (no soil amendment). The decrease in growth and yield of cassava at increase rate could be that the lime was in excess rate compare to 100kg/ha that could be optimum in the experimental soil. Howeler (1996) observed that excessive concentration of lime poses risks to the crop environment. Umoh *et al.*, (2017) reported that higher dosage of lime decrease tuber yield and dry matter adopted to poor or degraded soil because of levels of exchangeable aluminum (Al) and low concentration of phosphorus in the soil solution. Akata, O. R., Udounang, P. I., & Udo, P. P. (2021) in their study concluded that cassava performed better in acid soil compared to alkaline soil.

Conclusion and Recommendation: Field experiment was conducted at Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus, in 2021 to evaluate the effects of Inorganic fertilizer and lime rate on chemical properties and yield of cassava. The experiment was laid out in a randomized complete block design, replicated three times with a 3×3 factorial arrangement. Factor A treatments were three NPK fertilizer rates (0, 200 and 300kg/ha) while factor B were three liming rates (0, 100 and 200kg/ha). The following growth and yield parameters were assessed; establishment percentage, plant height, number of leaves per plant, leaf area, number of branches per plant, number of tubers per plant, length, tuber circumference and tuber yield. The treatment of 300kg/ha performed best in all the growth and yield parameters assessed, followed by the treatment of 200kg/ha. The least was recorded in control (no fertilizer) treatment.Among the liming rates, the treatment of 100kg/ha superseded the other treatments in all the growth and yield parameters assessed. The least was recorded in control (no lime application) treatment. The interaction between NPK fertilizer and liming rates varied significantly (P<0.05).

The interaction of 300kg/ha NPK and 100kg/ha performed best in all the parameters evaluated, this was followed by interaction of 300kg/ha NPK and 200kg/ha lime. The least performed interaction affect was observed in the treatment interaction of no fertilizer application and no lime application. Based on the findings, the application of 300kg/ha NPK produced significant tuber yield while control produced the least. The 100kg/ha lime treatment produced significant tuber yield while control produced the least. The treatment interaction of 300kg/ha NPK and 100kg/ha lime, produced significant tuber yield. It is therefore recommended that farmers should apply 300kg/ha to cassava, also should incorporates 100kg/ha lime during land preparation (tillage) for proper growth and development.

References

Akata, O. R. (2015). Influence of Organic manure on Soil Fertility, Weed Flora Dynamics and Performance of Cassava in Uyo, Nigeria Ph.D Thesis in Crop Production. University of Calabar, Calabar.

Akata, O. R., Akpan, E. A., & Enyong, J. K. (2016). RESPONSE OF TEN WATER YAM (DIOSCOREA ALATA L) GENOTYPES TO MINISETT CULTIVATION IN OBIO AKPA, AKWA IBOM STATE. *Nigerian Journal of Horticultural Science*, *26*(3), 2022.

Akata, O. R., Udounang, P. I., & Udo, P. P. (2021) Effect of cutting orientation on the growth and yield of cassava (Manihot esculenta crantz) In Obio akpa, Akwa Ibom State. Journal of Agriculture, Forestry & Environment. 5(1): 84 - 90

Akata, O. R., Uko, A.E., Nwagwu, F.A., Ndaeyo, N. U., Ikeh, A.O., and Essang, D.M. (2016). Weed dynamics, growth and yield of cassava (Manihot esculenta Crantz) as influenced organic fertilizer sources and rates in an Ultisol. Journal of Basic and Applied Research International, 18(2), 68- 76.

Ben, F. E., Okpara, D. A., Akpan, E. A., Udounang, P. I., Akata, O. R., & Inyang, P. (2024). Response of orange–Fleshed sweetpotato (Ipomea batatas (L) Lam) to ratoon cropping and nutrient management in Southern Nigeria. *International Journal of Agricultural Policy and Research*, *12*(2), 23.

Ekwere, O. J., Akpan, E. A., & Akata, O. R. (2019). Performance and yield of fluted pumpkin (Telfairia occidentalis (f.) hook) on an ultisol amended with soybean meal. *J. Agric. Environ. Resour. Manag. ISSN2245–1800 (paper) ISSN*, 2245-2943.

Ekwere, O. J., Udounang, P. I., and Akpaninyang, F. E. (2023b). Evaluation of four white yam (dioscorea rotundata poir.) cultivars for seed yam production in Obio Akpa, south eastern Nigeria. *Nigerian Journal of Horticultural Science*, *27*(2).

Enyong, J. F., Ndaeyo, N. U., Ndon, B. A., Ugbe, L. A., and Akpan, E. A. (2013). Preliminary evaluation of effects of herbicide types and rates on growth and yield of cassava (Manihot esculenta Crantz). *International Journal of Basic and Applied Sciences*, *2*(2), 65-70.

Essien, O. A., Sam, I. J. and Umoh, F. O. (2019). Effect of Raindrop Impact and its Relationship with Aggregate Stability on Sandstone/Shale Parent Material in Akwa Ibom State. *Nigerian Journal of Agricultural Technology*. Pp 16: 66 – 73.

Graham, R. D., Welch, R. M., Bonis, H. E. (2001). Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: principles, perspective and Knowledge gaps. *Advances in Agronomy 70, 77 – 142.*

Howeler, R. H. (1996). *Diagnosis of Nutritional disorders and soil fertility maintenances of cassava.* In: Kurup, G. T. *et al* (Eds). Tropical Tuber Crops: Problems, Prospects and Futures Strategies. Oxford and IBH Publishing co. Pvt. Ltd., New Delhi, India, PP.

Ibia, T. O. and Udo, E. J. (2009). Guide to fertilizer use for crops in Akwa Ibom State. Ministry of Agriculture and Natural Resources, Uyo, Akwa Ibom State. *Sinon Book limited Lagos* 104 pages.

Ikeh, A. O., Ndaeyo, N. U., Akpan, E. A., Udoh, E. I. and Akata, O. R. (2013). Evaluation of Complementary use of organic manure for sustainable water yam in Uyo, Southern Nigeria. *American Journal of Research Communication.* 1(2): 33 – 48.

Maurice, B. P., & Akata, O. (2022). Evaluation of Genetic Variations and Agronomic Performance of Some Cultivars of White Yam (Dioscorea rotundata) in Obio Akpa, Nigeria. *International Journal of Innovative Research and Development*, *11*(7).

Ogban, P. I., Ibotto, M. I., Utin, U. E., Essien, O. A. and Arthur, G. J. (2022). Effect of Slope Curvature and Gradient on Soil Properties Affecting Erodibility of Coastal Plain Sands in Akwa Ibom State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension.* Pp 21: 12 – 23.

Roger, B. (2014). The diffusion of Cassava in Africa: lexical and other evidence. Kay Williamson Education Foundation 8, Guest Road Cambridge CBI 2AL, United Kingdom. (Google Scholar).

Slus A-K (1989). Physical Background, Soil Landuse and ecoly problem. Technical Report of the Task Force on the soil and Landuse Survey, Akwa Ibom State. The Government Printer, Uyo, Nigeria.

Thomas, I. U., Ekwere, O. J., and Akpaninyang, F. E. (2023). Response of Orange-fleshed Sweetpotato (Ipomoea batatas (L)) varieties to NPK fertilizer in Obio Akpa, Akwa Ibom State. Nigerian Journal of Agriculture, Food and Environment. 19(1): 58-64

Udounang P. I, Essien, O. A, Umoh, F. O., Ijah, C. J., and Akpainyang, F. E. (2023) Evaluation of Growth and Yield of Cocoyam on Varying Rates of Organic Manure in a Cocoyam Based-Intercropping System. American Journal of Life Sciences 11(3):44-49. https://doi.org/10.11648/j.ajls.20231103.13

Udounang, P. I., Ekwere, O. J., & Akata, O. R. (2021). Evaluation of Morphological Characters and Yield Variability of Some Elite Cassava (Manihot Esculenta Crantz) in Uyo, Southeastern Nigeria. *American Journal of Agricultural Science, Engineering, and Technology*, *5*(2), 102-112.

Udounang, P. I., Ekwere, O. J., & Akata, O. R. (2022). Effect of different tillage practices on the growth and yield of ginger (Zingiber officinale Rosc.) in Obio Akpa-Akwa Ibom State, South Eastern Nigeria. *AKSU J Agri Food Sci*, *6*(1), 36-45.

Umoh, F. O., Osodeke, V. E., & Akata, O. R. (2017). Evaluation of potassium fixation capacity and residual values in soils of South-eastern Nigeria. *Greener Journal of Soil Science and Plant nutrition*, *3*, 022-029.

Uwah, D. F., Effia, E. B., Ekpeyong L. E., and Akpan, I. E. (2009). Cassava Performance as Influenced by Nitrogen and Potassium Fertilizers. In Uyo, Nigeria. Department of Crop Science, University of Calabar, Nigeria.