ISRJ ONLINE
INTERNATIONAL SCIENCE RESEARCH JOURNAL
ISSN: 2006-1730

NUTRIENT UPTAKE AND ROOT YIELD OF CASSAVA AS INFLUENCED BY LIMING AND POULTRY MANURE UNDER DIFFERENT CROPPING SYSTEMS.

***[1]Anyaegbu P.O, [2]Iwuanyanwu U.P. And [3]Ekwugha E.U.,**

[1]University of Abuja, Nigeria.
[2]Federal University of Technology, Owerri, Imo State, Nigeria.
[3]Imo State Polytechnic, Umuagwo, Imo State, Nigeria.

ABSTRACT: The trials were carried out at Umuagwo, Imo state to investigate the nutrient uptake and root yield of cassava under different cropping systems as influenced by poultry manure (0,5,10 t ha^{-1}) and Lime(0, 10 t ha^{-1}) A split plot treatment arrangement fitted into Randomized Complete Block Design with 3 replications was used. In 2008, leaf Nitrogen and available P increased by 27% and 51% respectively in areas given poultry manure over the control plots while in 2009, the results stood at 53% and 51% respectively. In 2008, Stands grown in areas with 10 t/ha of lime produced 31% in 2008 and 27% in 2009 more storage roots than those grown in the Control plots, irrespective of cropping systems. Fresh root yield peaked at 28.3tha^{-1} in the sole crop plots and 24.2 t ha^{-1} in the intercrops at the combined application of 5 t ha^{-1} of poultry manure and 10 t /ha of lim. More root yield was recorded in 2009 than in 2008. Mixture productivity of cassava and maize rose above 1 in all plots that received poultry manure and lime in the two years of trial.

KEY WORDS: Nutrient uptake, cassava, cropping systems, Poultry manure, lime, residual effects etc.

INTRODUCTION

Manihot esculenta is one of the major carbohydrate staple food crops in Nigeria (and in Africa generally), especially from the Rainforest to the Guinea Savanna agro-ecological zones of the Country *(Wiley 1979)*. It is used for industrial starch, ethanol and in the production of Cassava Powder and Chips/Pellets.

In Nigeria, the Federal Government lately, has realized the potentials in export of *Manihot esculenta* products particularly, cassava chips. Since then there has been a frenzy of activities with government forming committees and action plan having out lined how much Nigeria is capable of making from cassava products. The crop(*Manihot esculenta*) is among the national priority crops in the current Agricultural Development Policy of Nigeria on which the Federal Government has projected to attain self-sufficiency on the short-run *(Anyaegbu 2008)*.

Meanwhile most of the cassava consumed in Nigeria especially in the South Eastern zone, are produced by small scale subsistence farmers practicing mixed cropping systems. The predominant crop combinations in the farming system of the area is *Manihot esculenta*. *Cramtz*, Zea *mays*, and green leafy-*Amaranthus hybrides* and fruity vegetables like *Telfairia occidentalis*, *Talinum triangulare*, *Capsicum species* and *Abelmoschus esculenthus (Ikeorgu et al 1989)*.

Many scientists, Farmers and agro-business groups have debated on how to make agriculture sustainable. One of the many practices, indicated by them includes growing a diverse number of crops in a single field *(Lindsay 2004)*. The system would replicate the biodiversity already found in natural environment, resulting in increased resistance to disease and decreased effects of erosion and loss of nutrients in soil.

Some farmers in Nigeria grow their crops on mounds while others adopt flat plating. It has been observed that most of these farmers spread house-hold refuse or poultry droppings in their farms as an alternative fertilizer since the chemical fertilizer is no longer available to them as a result of its exorbitant price.

Unfortunately some of them obtain low yield from cassava because little information is available as to the best combination of minor crops, manures and the planting pattern of these crops which vary in their combination involving roots, cereals, legumes and vegetable crops. Therefore this study is designed to assess the nutrient uptake and root yield of cassava as affected by poultry manure and lime application under different cropping situations (intercropping and sole cropping).

MATERIALS AND METHOD

Two trials were conducted at the teaching and research farm of lmo State Polytechnic, in 2008 and 2009 Cropping Seasons. The Polytechnic, located in the rainforest region in Nigeria has a total annual rainfall of 2000- 2500mm.

The site was under one year fallow following a trial involving *Telfairia* seedling emergence as influenced by different tillage practices. In 2008, the experimental site was cleared and ploughed with tractor. In 2009, clearing was restricted to individual plots. Shortly after ploughing in 2008, soil samples (10-15cm) and (15-30cm) were collected randomly within the experimental layout for preliminary soil analysis for N,P,K, Organic Carbon, Sodium, Base satiation and pH, (Table 1). Post harvest soil analysis was also carried out in 2009 to determine the effects of lime and poultry manure on the soil chemical properties.

An improved *Manihot esculenta* variety (TMS 419),early maturing, sweet, with about 3.3mg /100g HCN content, branching pattern sparse, resistant to Cassava, Mosaic Virus (CMB) Cassava Bacterial Blight (CBB) and Cassava Mealy bug, very high yielding and with good adaptation and compatibility in mixed cropping, was obtained from IITA Onne, River state, Nigeria.

***Corresponding Author:** E-mail: anyaegbupoly@rocketmail.com

The maize *(Zea mays)* variety, Downy Mildew Resistant, Early Streak Resistant Yellow (DMR-ESRY), characterized by 60 days maturing period, compatibility in crop mixtures, high carotene ,large cobs and ears well filled at maturity.

The main experimental treatments in the trial include lime (0, 10 t ha^{-1}), Poultry manure (0, 5, 10 t ha^{-1}) and Cropping Systems (sole crop cassava and cassava mixed with maize). The levels of the various treatments were organized with split-plot treatment arrangement and fitted into Randomized Complete Block Design. Cropping systems constituted the whole unit, lime-subplot and poultry manure constituted the sub, sub -plot. Thus the 2x2x3 treatment combinations(Table 3) were systematically organized and fitted into Randomized complete Block Design (RCBD) with 3 replicates. Each replicate (41.5m long) contained 12 plots giving a total of 36 plots for the trial. Each plot measured 3mx3m, separated from one another by 0.5m within replicate and 1 m between replicates. Thus the experimental layout covered an area of 456.5 m^2. Planting spacing for maize was 90mx90cm with two seeds per hole, giving a population of 24, 691.36 stands /ha while that of cassava was I m x I m with one cutting per hole, giving a population of 10,000 Stands /ha.

For 10 t ha^{-1} of lime and 10 t ha^{-1} of Poultry manure , a plot received 9kg of lime and 9 kg of poultry manure respectively and for 5 t ha^{-1} of poultry manure a plot received 4.5 kg. The poultry manure and lime were factorially combined and applied as a unit of treatment combination, 7 days before planting to allow the manure to set properly. The treatments applied were manually incorporated into the soil by tilling to a depth of 0-30 cm using Garden Fork.

Herbicides were not applied. Weeding was done twice using hoe; 3 weeks after planting and at the period of taseling of maize crop.

Cassava leaves of five randomly selected stands in the net plot area were detached, dried and ashed. Total Nitrogen (by modified *Microkjeldah method*; *Jackson 1969),* available Phosphorus (*Bray-No2 method; Bray and kurz 1945)* and Potassium (Flame Photometer), were determined. Data were also collected on height/plant ,number of marketable roots/plant, fresh root yield (t ha^{-1}), Mixture Productivity of the Cropping Systems using Land Equivalent Ratio (LER) was determined.

After harvesting cassava in 2008 and 2009, post harvest soil chemical analyses were carried out to evaluate the current and residual effects of lime and poultry manure on the soil nutrient status.

Analyses of variance were carried out on each parameter assessed. Means were compared with by LSD and DMRT under different conditions.

RESULTS

The Pre-Planting Soil Chemical analysis showed that the soil pH, organic carbon and total nitrogen were low (Table 1). ECEC (less than 10 meg/100g soil) and chemical analysis of the Poultry manure shown in Table 2, indicates high content of Nitrogen, Organic Matter, Calcium, Magnesium and C: N ratio.

Irrespective of cropping systems and lime rates, height of cassava plants tended to increase linearly and significantly (p>0.05) as poultry manure rates increased, (Table 4). Plant growth in control plots (no poultry manure, no lime) was relatively poor irrespective of cropping systems, though poorer in intercrop plot than in sole crop plots.

Liming up to 10 t ha^{-1} improved the growth of cassava significantly (p>0.05) in both cropping systems. Percent leaf Nitrogen in cassava was significantly (p>0.08) increased with application of poultry manure and lime in both cropping systems, (Table 5). In 2008, leaf nitrogen increased by 53% with poultry manure application over those obtained in control plots. Generally in both cropping systems increase in poultry manure application resulted in increase in leaf Nitrogen content. Increasing poultry manure rate from 5 t ha^{-1} to 10 t ha^{-1} led to resultant increase in leaf nitrogen content of cassava by 21% in sole and 27% in the intercrops in 2008 and by 27% in sole and 31% in the intercrops in 2009 respectively. However liming at 10 t ha^{-1} significantly (p>0.0.5) increased nitrogen content in the leaves of cassava. Mean while statistical interaction (Poultry x lime x cropping systems) was significant in both cropping system. The phosphorous content in cassava leaves as influenced by Poultry manure and lime application in both cropping systems is shown in Table 6. Irrespective of lime rates, application of poultry manure increased phosphorous content by 51% in cassava sole crops, and 52% in the intercrop in 2008 and 56% in sole crops and 51% in the intercrop in 2009 over Control plots. Liming at 10 t ha^{-1} improved the cassava leaf Phosphorous. However the content of phosphorous in cassava leaves remained the same in both cropping systems for 2008 and 2009 cropping seasons respectively.

In the first year of cropping (2008), application of poultry manure significantly increased Potassium content of cassava leaves, (Table 7). In the second year leaf Potassium content remained fairly the same irrespective of increased poultry manure. However, applying poultry manure beyond 5 t ha^{-1} did not increase availability of potassium in cassava leaves. In both cropping systems and for the two years of the trial, applying lime up to 10 t ha^{-1} did not change the potassium status of cassava leaves.

Cassava leaves in sole crop plots contained more potassium than those in the intercrop plots significantly (p>0.05).There was significant increase in the number of marketable roots per stand of cassava with poultry manure application and liming (Table 8). In 2008 cropping season, stands that received poultry manure produced more number of roots by 70% in sole and 78% in the intercrop plots over the stands in the control plots, while in 2009, the production stood at 75% in sole crops and 67% in intercrops more than those in the control plots. At 10 t ha^{-1}, lime ,stands that were given poultry manure also produced more roots than those that received only lime by 56% in sole crops and 69% in intercrops in 2008 and 75% in sole crops and 68% in intercrops in 2009.

In 2008, stands in sole crops plots produced 22% more roots than those in intercrops while in 2009, the production stood at 12%.

In 2008, cassava stands that received 10 t ha^{-1} of lime, irrespective of poultry manure application, produced more roots than those in control plots by 29% in sole crop and 33% in the intercrops plots while in 2009; the production stood at 21% in sole crops and 33% in the intercrop plots. Generally, more roots were produced in the second year of the trial compared with the first year (2008). However, statistical interaction (lime x poultry x cropping systems) was significant ($p>0.05$).

The fresh root yield of cassava as influenced by liming and poultry manure is shown in Table 9. Application of lime at 10 t ha^{-1} significantly ($p>0.05$) affected cassava root yield. In 2008, application of lime increased root yield by 29% over those in the control plots while in 2009, the yield increase was by 49% in sole crops and 52% in the intercrops plots.

Irrespective of cropping systems, application of poultry manure significantly (p> 0 0.5) increased root yield of cassava. In all plots where there was no lime application, root yield increased linearly with increase in poultry manure up to 10 t ha^{-1} but in areas that were treated with 10 t ha^{-1} of lime, cassava root yield peaked at 5 t ha^{-1} of poultry manure application. Beyond it there was no significant increase in root yield of cassava .More root yield was recorded in 2009 than in 2008.

The mixture productivity of cassava and maize, assessed with land Equivalent Ratio ,is shown in Table 10. Land Equivalent Ratios of the intercrops that received poultry manure and lime were all above one. In control plots ,the LER was less than one. Highest LER was recorded from the intercrops that received treatment combination of 10 t ha^{-1} of poultry manure and 10 t ha^{-1} of lime.

The mean values of the effects of lime and poultry manure application on PH, Nitrogen, Phosphorous, potassium, calcium and organic carbon under cassava sole crops and its intercrops with maize is presented in Table 11. There was significant effect ($P>0.05$) on soil PH compared with the control. Soil pH rose steadily with increase in manure application. Application of lime at 10 t ha^{-1} increased the pH from 4.0 to 5.0 in sole crop plots and from 4.1 to 5.1 in intercrops plots in 2008. In 2009, it increased from 4.0 to 5.6 in sole crops plots and from 4.4 to 5.8 in intercrop plots. The status of the basic elements analysed was significantly improved by the lime and poultry manure application. Potassium content in sole crop plots was significantly ($p>0.05$) greater than that in intercrop plots in the two years of the trial.

Table 1: Preliminary soil analysis of the experimental site in 2007

Parameters	UMUAGWO		FUTO, OWERRI	
	0 – 15cm	15 – 30 cm	0 – 15 cm	15 – 30 cm
PH in water	4.4	4.3	4.5	4.4
PH in K_2O (1:2:5)	4.3	4.2	4.4	4.4
% organic carbon	1.19	0.48	1.20	0.51
Total Nitrogen (%)	0.37	0.31	0.37	0.32
Available P (ppm)	21.3	10.5	24.10	14.15
Potassium (Cmol kg^{-1})	0.11	0.09	0.18	0.11
Sodium (Cmol kg^{-1})	0.14	0.14	0.12	0.12
Base saturation (%)	68	51	76.6	70.1
ECEC	3.05	2.41	3.36	2.53

Table 2: Chemical Properties of the Poultry Manure used in the trial.

ELEMENTS	QUANTITY (%)
Nitrogen (N)	1.48
Phosphorus (P)	1.32
Potassium (K)	0.55
Magnesium (Mg)	1.93
Calcium (Ca)	6.90
Carbon Nitrogen Ratio (C:N)	19.8:1
Organic carbon (C)	26.53
Sodium (Na)	0.53

Table 3: Treatment combinations of the 2 x 2 x 3 split plot arrangement used in this study

Cropping Systems : Sole cropping (A_1) Intercropping (A_2)

Lime Rates : 0 (B_1) 10 t ha^{-1}(B_2)

Poultry Manure rates: 0 (C_1) 5 t ha^{-1}(C_2) 10 t ha^{-1}(C_3)

Treatment Combinations	Cropping systems	Lime rates (t ha^{-1})	Poultry manure (t ha^{-1})
$A_1B_1C_1$	Intercrop	0	0
$A_1B_1C_2$	Intercrop	0	5
$A_1B_1C_3$	Intercrop	0	10
$A_1B_1C_4$	Intercrop	10	0
$A_1B_1C_5$	Intercrop	10	5
$A_1B_1C_5$	Intercrop	10	10
$A_2B_1C_1$	Sole cropping	0	0
$A_2B_1C_2$	Sole cropping	0	5
$A_2B_1C_3$	Sole cropping	0	10
$A_2B_2C_1$	Sole cropping	10	0
$A_2B_2C_2$	Sole cropping	10	5
$A_2B_2C_2$	Sole cropping	10	5
$A_2B_2C_3$	Sole cropping	10	5

Table 4: Height (m)/ plant of cassava in mixed and in sole as influenced by lime and poultry manure application.

Lime rate (t ha^{-1})	**Poultry** manure (t ha^{-1})	**Height (m)/Plant** **2008**		**2009**	
		Sole crop	Inter crop	Sole crop	Inter crop
	0	0.71	0.51	0.44	0.5
	5	2.14	2.20	2.23	2.1
O	10	3.33	2.81	2.78	3.2
Mean+ S.E.		2.06 +			

Table 5: Cassava Leaf Nitrogen content (%) in mixed and in sole as affected by lime and poultry manure application

Lime rate (t ha^{-1})	**Poultry** manure (t ha^{-1})	**Nitrogen Content (%)** **2008**		**2009**	
		Sole crop	Inter crop	Sole crop	Inter crop
	0	0.21	0.18	0.11	0.08
	5	0.33	0.26	0.30	0.24
O	10	0.52	0.43	0.52	0.45
Mean ± S.E.		0.35 ± 0.004	0.29 ± 0.118	0.31 ± 0.017	0.27 ±0.015
	5	0.36	0.24	0.28	0.19
	0	1.20	1.08	1.20	0.74
10	10	1.36	1.23	1.37	1.06
Mean ± S.E.		0.97 ± 0.003	0.85 ± 0.032	0.95 ± 0.066	0.66 ± 0.006
LSD (Poultry manure)		0.11			0.19
LSD (Lime)		0.27			0.24
LSD (Cropping systems)		0.08			0.16
Statistical interaction		*			*
C.V.		8.3			10.3

S.E. = Standard Error
* = Significant @ 95%

Table 6: Cassava leaf Phosphorus (P) content (%) in mixed and in sole as influenced by lime and poultry manure application.

Lime rate (t ha^{-1})	Poultry manure (t ha^{-1})	Phosphorus Content (%) 2008 Sole crop	2008 Inter crop	2009 Sole crop	2009 Inter crop
	0	0.31	0.21	0.19	0.20
	5	0.59	0.38	0.55	0.53
O	10	0.58	0.43	0.56	0.54
Mean ± S.E.		0.49 ± 0.03	0.34 ± 0.011	0.43 ± 0.031	0.42 ± 0.014
	0	0.44	0.42	0.46	0.46
	5	0.55	0.53	0.57	0.57
10	10	0.56	0.58	0.57	0.57
		0.52 ± 0.022	0.51 ± 0.040	0.53 ± 0.110	0.53 ± 0.110
LSD (0.05)(Poultry manure)		0.11			0.21
LSD (0.05) Lime		0.02			0.05
LSD Cropping systems		ns			ns
C.V.		8.36			7.75
Statistical interaction		*			*

S.E. = Standard Error
* = Significant @ 95% confidence level.

Table 7: Cassava leaf Potassium in mixed and in sole as influenced by lime and Poultry manure application.

Lime rate (t ha^{-1})	Poultry manure (t ha^{-1})	Potassium Content (%) 2008 Sole crop	2008 Inter crop	2009 Sole crop	2009 Inter crop
	0	0.26	0.24	0.20	0.23
	5	0.41	0.32	0.46	0.26
O	10	0.49	0.42	0.49	0.26
Mean ± S.E.		0.38 ± 0.03	0.330 ± 0.11	0.38 ± 0. 31	0.25 ± 0.01
	0	0.31	0.25	0.20	0.24
	5	0.40	0.33	0.47	0.37
10	10	0.42	0.39	0.48	0.30
Mean ± S.E.		0.38 ± 0.03	0.32± 0.13	0.38 ± 0.14	0.27 ± 0.10
LSD (Poultry Manure)		0.08			ns
Lime		ns			ns
LSD (Cropping systems)		0.03			1.16
Statistical interaction		*			*
C.V.		10.6			7.3

Table 8: Number of marketable cassava storage roots per plant in sole and mixed with maize, as influenced by Poultry manure and lime application.

Lime rate (t ha^{-1})	Poultry manure (t ha^{-1})	Number of marketable "Roots" / Plant 2008 Sole crop	2008 Inter crop	2009 Sole crop	2009 Inter crop
	0	2	1	3	2
	5	5	3.3	7.6	4.2
O	10	6.4	5.7	10.1	6
Mean ± S.E.		4.5 ± 1.18	3.3 ± 1.17		
	0	5.4	3	4	4
	5	8.7	7.6	12.5	8
10	10	10.5	9	15	12.8
Mean ± S.E.		8.2 ± 1.53	6.5 ± 1.02	10.5 ± 1.61	8.3 ± 1.41
LSD (Poultry Manure)		1.86			2.63
LSD (Lime)		2.34			2.18
LSD (Cropping systems)		1.96			1.17
Statistical interaction		*			*
C.V.		8.50			6.14

Table 9: Fresh Root yield of cassava in sole and mixed with maize as influenced by lime and poultry manure.

Lime rate (t ha^{-1})	**Poultry** manure (t ha^{-1})	**Fresh Root Yield (t ha^{-1})** **2008** Sole crop	Inter crop	**2009** Sole crop	Inter crop
	0	2.5	3.3	3.5	2.3
	5	7.3	6.4	7.6	5.4
O	10	11.9	11.3	11.8	8.6
Mean ± S.E.		7.2 ± 1.01	7.0 ± 0.01	7.6 ± 1.61	5.4 ± 1.21
	0	8.1	7.8	6.3	4.4
	5	14.6	12.6	28.3	24.2
10	10	16.4	14.3	28.7	23.6
Mean ± S.E.		13.0 ± 1.81	11.6 ± 1.22	21.1 ± 1.84	17.4 ± 1.19
LSD (0.05) Poultry				2.11	1.71
LSD (0.05) Lime				2.37	4.76
LSD (0.05) Cropping systems				2.08	1.7
Statistical interaction				*	*
C.V.				8.4	10.2

Table 10: Mixture Productivity of Cassava with its Component Crop (maize), assessed with Land Equivalent Ratio (LER), as influenced by Poultry Manure andLime.

	Poultry manure (t ha$^{-1)}$	**UMUAGWO** **2008**		**2009**	
		Lime Rates ha^{-1}			
		0	10	0	10
	0	0.81	1.10	0.7	1.18
	5	1.14	1.32	1.16	1.41
	10	1.22	1.44	1.32	1.42
Mean ± S.E.		1.06	1.29		
LSD (p>0.05)		0.08		0.17	

Table 11: Chemical properties of Soil under Sole Crop and Intercropped Cassava as influenced by Lime and Poultry Manure.

Lime rates	Poultry manure	**SOLECROPS** **2008** **ELEMENTS** PH	N%	P	K	Ca	**INTERCROPS** PH	N%	P_{PPM}	K	Ca
-	0	4.0	1.31	3.4	0.3	0.10	4.1	1.20	3.6	0.2	0.09
0	5	4.2	2.6	6.4	0.58	0.31	4.4	2.5	6.8	0.4	0.30
-	10	4.5	4.3	8.6	0.71	0.61	4.2	4.2	8.2	0.6	0.58
	0	4.6	2.8	5.4	0.2	0.5	4.6	2.2	4.6	0.2	0.48
	5	4.5	4.3	8.8	0.42	0.86	5.1	4.5	13.3	0.4	0.74
10	10	5.0	5.4	10.5	0.64	1.02	5.1	5.1	16.5	0.5	0.91
FLSD		0.064	0.039	1.24	0.03	0.047	0.021	1.04	1.84	0.161	0.085
2009											
	0	4.0	1.28	3.2	0.2	0.41	4.4	2.5	2.8	0.11	0.05
0	5	4.2	2.6	6.1	0.43	0.78	4.6	3.4	6.3	0.3	0.31
	10	4.3	4.3	7.6	0.61	1.20	4.8	4.0	7.9	0.4	0.45
	0	5.0	2.4	3.1	0.3	0.61	4.7	2.2	4.2	0.2	0.21
10	5	5.3	3.2	6.8	0.58	1.05	5.5	4.3	14.0	0.43	1.07
	10	5.6	4.2	8.4	0.63	1.68	5.8	4.8	16.1	0.51	1.66
FLSD		0.051	0.04	1.18	0.14	0.02	0.042	1.06	1.54	0.013	0.07

DISCUSSION

The pre-planting soil chemical analysis showed low soil pH, organic carbon and total nitrogen and Exchangeable Cat ion. Apart from being under one year fallow following a two year *Telfairia* trial, the poor state of the soil in the experimental site confirmed the work done by *Ohiri (1992*) who reported that soil in Imo, Abia Akwa Ibom States belong to group 11, characterized by low pH, low organic Carbon and low Exchangeable Cat ions. The low pH level represents a limiting factor for increased productivity of Roots and tuber Crops *(Enwezor et al 1981).* The chemical analysis of the poultry manure used indicates high content of Nitrogen, Organic matter, Calcium, Magnesium and C:N ratio. The superiority of poultry manure over other organic manure has been confirmed by *Hsich and Itsu (1993).Cooke (1982)* reported that an estimate of 100 tones/ha of poultry manure would supply 50kg N/ha, 30kg p_2O_5/ha and 50kg K_2 O/ha.

Plant growth in the control areas was relatively poor. This was as a result of the poor state of the soil due to poor management and due to its natural phenomenon as attributed by *Ohiri (1992).* Plant height increased significantly with application of lime and poultry manure. The main nutrients supplied by poultry manure according to *Hemingway (1961)* are nitrogen , phosphorous and potassium. *Gupta (1970)* attributed the increase in height of maize to increase in the amount of mineral Nitrogen, Phosphorus and Potassium. *Gupta (1970)* attributed the increase in height of maize to increase in the amount of mineral nitrogen. Hence adequate nitrogen supply is known to produce vigorous vegetative growths in plant *(Anyaegbu et al 2007).*

Heights of plants grown in areas limed (10 t ha^{-1}) were improved significantly. This confirms the roles attributed to lime that it improves the positional availability of nitrogen and other basic elements through its ability to improve the pH of the soil.

The increase in the contents of the basic elements, nitrogen, phosphorus and potassium in the leaves of cassava in both cropping systems with increase in poultry manure and lime rates indicates that significant interaction existed between lime and poultry manure.

The above results were similar to those of the chemical analysis of the soil for the basic elements and soil pH. The positive increase in available soil Phosphorus with increase in liming in this trial, confirms the work of *Kamprath (1972)* which reported that available P was high with liming up to PH 5.5. In this trial, the soil pH increased up to 5.6 with liming. However, in the two years of trial, the soil exchangeable potassium (K) was significantly higher in the sole crop plots than in the mixture. This was probably because of high need of K by maize for grain development *(Anyaegbu 1988).* The general decrease in the amount of soil exchangeable K with increase in liming clearly indicated that liming increases plant efficiency in the use of potassium simply by removing other growth limiting factors and improving the potential availability of Potassium through an expanded and more effective root system, *(Peeche and Bradfield 1943). Anyaegbu (1988)* reported that liming decreased leaching loss of potassium and tend to increase reversion of Potassium to less soluble forms.

The positive effects of liming and Poultry manure application on the soil chemical properties and vegetative characters of cassava resulted in increased roots yield of cassava and improved its mixture productivity with maize. However, in all plots where there was no lime application, root yield increased linearly with increase in poultry manure up to 10 t ha^{-1} but in areas treated with 10 t ha^{-1} of lime, root yield of cassava increased significantly up to 5 t ha^{-1} of poultry manure. Beyond it (5 t ha^{-1} of lime), there was no significant increase in root yield.

Thus applying poultry manure beyond 5 t ha^{-1} at 10 t ha^{-1} of lime only promotes more vegetative growth than root yield.

Thus, a farmer interested in cassava stem yield is encouraged to apply up to 10 t ha^{-1} of poultry manure when his/her farm was limed up to 10 t ha^{-1}. Root yield was more in 2009 than in 2008. This may be attributed to the residual effects of lime.

CONCLUSION

High soil acidity was observed before the commencement of the trials. There was increase in the Organic Carbon of the soil after crop harvest. Available P, Total Nitrogen and Potassium contents of both the cassava leaf and that of the soil were moderately increased after harvest.

Cassava stands given poultry manure and 10 t ha^{-1} of lime produced were relatively better in terms of height, number and marketable roots, root yield and mixture productivity over those grown in control plots.

In the two years of trial, cassava root yield did not increase significantly beyond 5 t ha^{-1} of poultry manure application at the lime level of 10 t ha^{-1}.

REFERENCES

Anyaegbu P.O. (1988), Effects of Lime and N-P-K (15-15-15) on intercropped maize and groundnut in the Humid Tropical Zone. *Master of Philosophy Thesis, 1988, University of Science and Technology, Port Harcourt, Rivers State, Nigeria.*

Anyaegbu, P.O., Ezeibekwe, I.O and Uwalaka R.E. (2007). Effects of different Organic Manure types on the growth performance of *Gnetuim Africanium. African Journal of Natural and Applied Science (IJONAS 2007), P 320 326.*

Anyaegbu P.O, Osakwe, J.C., Ogburia M.N, Ikpe F.N. and Ezeibekwe, I.O. (2008) Comparative Assessment of Four Crops Species for soil fertility maintenance, weed suppression and sustainable Crop yield in *Manihot esculenta* (cassava) based Cropping Systems. *International Science Research Journal v(2) , 120 124.*

Bray, R.H. and Kurz H. (1945) Nutrient Mobility Concept of Soil plant relationships. *Soil Science, 56: 150 241.*

Cooke, G.W., (1982) Fertilizing for maximum yield. Grana Publishing Ltd. *ELBC Edition, 455p.*

Enwezor, W.O.E., Udo, N.J., Usomoh, K.A. and Jotade, A. (1981). Fertilizer Procurement and distribution of division (EPDD) 1981. *Fertilizer use and Management Practices for Crops in Nigeria.*

Gupta, E. (1970) Effects of Nitrogen and plant population on stem diameter and proportion of lodged plants in the maize hybrids, BSCK; 39-4 and OSSK 318. *Field Crop Abstract 32 (2), 101.*

Hemingway, D.C. (1961) Restoring and Maintaining the productivity of West African soils. Key to Sustainable Development. *International fertilizer development centre, Muscle Shoals, Alabama, p49.*

Hsich, C.F and Itsu K.N. Organic farming of Sweet Corn and Vegetable Soya Beans. *Bull Taichung District. Agric. Improvement Sta. No 39. 29 39*.

Ikeorgu J.E.G, H.C. Ezumah and Wahua T.A.T. (1989) Productivity of Species in Cassava / Maize / Okra / Egusi-Melon complex mixture in Nigeria. *Field crop Res. 21:20-25.*

Jackson, M.L. (1969) Soil Chemical Analysis of Alfisols. *American Soc. Of soil Sc, v.2 (61 - 65).*

Kamprath, E.J. (1971) Potential detrimental effects from liming highly weathered soils to neutrality. Soil, crop science society fla. Proc. 31:200-203.

Lindsay B.A. (2004). Intercropping Principles and Production Practices. *Http://attrancat.org/attra-pub/intercrop.html*.

Ohiri, F. (1992) Relative Sowing Time and Density of Component Crops in a Maize/Cowpea Intercropping System. *Experimental Agriculture, 23:41-52*.

Peeche S.C. and Bradfield S.R. (1945). Liming of highly weathered Soils of the Humid Tropics. *Soil Science Society of America, 37:716-721*.

Willey, R.W. (1979) Intercropping its importance and research. Weeds Part 1: Competition and yield advantage. *Field Crops Abstract, 32 (1):1-10.*