Soil and Plant Nutrient Composition, Growth and Yield of Cassava as Influenced by Integrated Application of NPK Fertilizer and Poultry Manure

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Abstract: The effects of combined application of reduced levels of NPK fertilizer (NPK) and poultry manure (PM) on soil and plant nutrient composition, growth and yield of cassava was studied at two sites in Akure, Southwest Nigeria. The treatments were the control, 600kg/ha NPK fertilizer (recommended), 10t/ha Poultry manure (PM), 5t/ha PM+300kg/ha NPK and 2.5t/ha PM + 450kg/ha NPK. Initial soils were low in organic matter (OM), very low in N and P and acidic. The PM used had relatively high N and P and good percentages of K, Ca and Mg. Results show that relative to control, NPK, PM, and their combinations increased soil OM, N, P, K, Ca and Mg significantly. The 2.5t/ha PM + 450kg/ha NPK gave highest values of the soil properties. Poultry manure alone, and in combination increased soil pH, while NPK reduced soil pH compared to the control treatment. There were significant increases in OM, P, K, Ca and Mg contents of cassava as a result of application of NPK, PM and their combinations. Nutrient content in cassava, growth and tuber yield parameters increased in the order of Control <NPK<PM<5t/ha PM + 300kg/ha NPK < 2.5t/ha PM + 450kg/ha NPK. Addition of NPK fertilizer to PM increased nutrient availability and performance of cassava. Relative to control, NPK fertilizer, PM, 5t/ha PM + 300kg/ha NPK and 2.5t/ha PM + 450kg/ha NPK increased tuber yield by 34, 28, 66 and 133% respectively, application of 2.5t/ha PM + 450kg/ha NPK is recommended.

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1. Introduction

Cassava root and its derivatives are dominant food in Subsahara Africa, being responsible for fifty percent of food intake and about 1000 calories per capital per day. This is also an industrial crop (Ojeniyi et.al, 2009). It is also an industrial crop. As at 1996, Nigeria was producing over 31 million tones of cassava, the highest in the world. However cassava production is limited by soil fertility status and this necessitates application of organic and inorganic fertilizers (Ojeniyi et.al, 2009) especially in Southeast Nigeria where scarcity of land militates bush fallowing. Cassava removes about 55kg/ha N, 132kg/ha P and 112kg/ha K (Howeler, 1991).

However farmers rarely use chemical fertilizer due to scarcity and cost, hence the dependence on cheap organic sources of nutrients. These reasons necessitate research on increasing effectiveness of organic manures and suitable rate of application.

Okigbo (1989) found that crop wastes such as those of legumes, rice and maize increased yield of cassava as mulch. In their own study Ezekiel et al. (2009a; 2009b)) and Ojeniyi et.al (2009) reported that oil palm bunch as at 2.5 to 5.0t/ha and the recommended 600kg/ha NPK 15:15 fertilizer significantly increased plant N, P and K, root growth and yield. On ultisols of Southwest Nigeria described as strongly to medium in acidity (Okereke et al., 1987), Eneji et.al (1997) observed that farmyard manure with NPK fertilizer increased yield of cassava relative to manure or fertilizer alone. Whereas on alfisols of Southwest Nigeria characterized with higher K content and medium to high base status, Agbaye and Akinlosotu (2004) observed significant reductions in yield of late season cassava due to application of 400 and 800kg/ha NPK 20:10:10 but no effect on early season cassava, fertilizer practice depends on pre-cropping soil test, soil, soil type and season. The effect of digester effluent was compared with pig and cattle manure (Weite et al., 1998) and it was found that bio digester effluent gave higher biomers, yield and protein content of cassava.

The effect of poultry manure on performance and nutrient composition of cassava and its suitable rate has not received adequate research attention especially on alfisols of Southwest Nigeria where cassava is a dominant crop. This work is a comparative study of the effects of NPK fertilizer, poultry manure and combined application of their reduced rates on growth, yield parameters and nutrients composition of cassava on alfisols of Southwest Nigeria.

2. Materials And Methods

To investigate the effects of combined application of NPK 15:15:15 fertilizer and Poultry manure (PM) on the soil chemical properties and performance of cassava in southwestern Nigeria, field experiments were conduted at two locations in the 2009/2010 cropping season. These locations were the Teaching and Research Farms of the Federal University of Technology Akure (FUTA) and the Federal College of Agriculture Akure (FECA). Akure ($7^0$16'N, $5^0$12'E) is located in the rain forest vegetation zone of Nigeria. Table 1 shows the nutrient status at 0-20cm soil depth at the two sites before planting cassava. The land used had been under seasonal cultivation to arable crops in the preceding years.

Table 1. Physio-chemical properties of the topsoil at the two sites before treatment application.

Soil properties	Experimental sites	
	FUTA (1)	FECA (2)
Sand (%)	62.00	48.00
Silt (%)	15.00	22.00
Clay (%)	23.00	30.16
Bulk Density (g/cm^3)	1.45	1.52
Organic matter (%)	1.80	2.00
Total nitrogen (%)	0.09	0.98
Available P (mg/kg)	4.91	4.19
Exchangeable K (cmol/kg)	0.34	0.88
Exchangeable Ca (cmol/kg)	3.21	4.33
Exchangeable Mg (cmol/kg)	0.70	1.02
pH	4.99	4.83
Soil textural class	Loamy sand	Loamy sand

Table 2. Chemical composition of poultry manure

Poultry manure (%)	OM	N	P	K	Ca	Mg
	69.2	4.9	4.1	1.9	1.0	0.9

The experiment was laid out in a completely randomized block design with three replications and the treatments imposed were: 600kg/ha NPK (15:15:15) fertilizer, 10 t/ha PM, 300kg/ha NPK + 5t/ha PM, 450kg/ha NPK + 2.5 t/ha PM and a control treatment where no fertilizer was applied.

Field preparation was by a tractor. The sites were ploughed and ridges constructed mechanically after which the treatments (manure types) were incorporated into the soil prior to planting of cassava cuttings. The cassava cuttings (variety TMS 0581), each 30cm long were planted at an inclination of about 45^0 and 2/3 of each buried into the ridge at a spacing of 1m x 1m along the ridge. Weeds were control with glyphosate at the tenth and twenty fourth weeks after planting cassava.

The parameters considered in the assessment of poultry manure, NPK fertilizer, and their combinations for the production of cassava were soil chemical and physical properties, growth and yield parameters of cassava and well as leaf nutrient components of cassava. The growth parameters considered were plant height (cm), stem girth (cm), number of leaves per plant and leave area (cm^2). The yield parameters taken were tuber length (cm), tuber girth (cm), number of tuber per plant, fresh tuber weight (t ha^{-1}) and fresh tuber yield (t ha^{-1}). The leaf nutrient indicator consideration was based on percentages of N, P, K, Ca and Mg present.

Pre-cropping chemical analysis of the experimental soil was carried out before land preparation and repeated at harvest at the two sites to determine the nutrient status of the soil. The soil samples were air dried, crushed, sieved, and then analyzed for total N using dichromate oxidation method".

Available phosphorus was by the Bray 1 method, Exchangable K, Ca and Mg were determined by extraction with 1M ammonium acetate at pH 7.0. K, Ca and Mg contents were determined as mentioned above. Soil pH (1:2 soil-water) was determined by pH meter, while organic matter (OM) was determined by dichromate oxidation method.

Poultry manure used for the conduct of the experiment was air-dried and milled. Samples were dry ashed at 500^0C for 6 hrs in furnace and extracted with nitric – perchloric acid mixtures (AOAC, 1990). N was determined by Kjedahl method, P by colorimeter, K by flame photometer and Ca and Mg were determined on ASS.

Data collected from the experiments at both sites were subjected to an analysis of variance, while treatment means were compared using the Duncan Multiple Range Test (DMRT).

3. Results

Some soil properties of the experimental sites (sites 1 and 2) are shown in Table 1.Table 2 shows the nutrient composition of poultry manure (PM).

The loamy sandy soil has high bulk density (> 1.40 g cm^{-3}), but it is low in organic matter, total N and available P, adequate in exchangeable K and Ca, and acidic. Testing poultry manure had relatively high contents of N and P compared with K, Ca and Mg.

Sole application of 600 kg/ha NPK fertilizer and 10t/ha poultry manure (PM) and combined application of NPK and PM at reduced levels

increased OM, N, available P and exchangeable K, Ca and Mg sufficiently at both sites of study (table 3).

Among soil NPK, PM and combined treatments, combination of 2.5+/ha pm +450 hg/ha NPK gave highest values of S0M, N, P, K, Ca and pH at both sites. Generally, soil P, K, Ca, and Mg increased in the order of control <NPK <PM <5+/ha PM +300kg/ha NPK < 2.5t/ha pm+ 450hg/ha NPK. Treatments involving PM had higher pH, and PM alone had highest soil pH. Thus it is shown that PM had liming effect due to supply of basic nutrients (K, Ca, Mg).

Table 4 shows the effects of the manure treatments on leaf nutrient composition of cassava. Application of NPK, PM and their combination at reduced levels increased leaf N, P, K, Ca and Mg concentrations. The increases in leaf N (site 2), Leaf P, K (Site1), Ca and Mg were significant as shown by the DMRT. Generally nutrients content tended to increase in the order control <NPK<PM<5t/ha PM + 300kg/ha NPK<2.5t/ha PM+450kg/ha NPK. The increases given by 2.5t/ha + 450kg/ha NPK relative to other treatments were significant in case of leaf K (Site 1) and leaf Ca (Sites 1 and 2).

Relative to control, NPK, PM, 5t/ha PM+300kg/ha NPK, 2.5t/ha PM + 450kg/ha NPK increased plant height significantly as shown by data collected at 1, 2, 3, 4, 5 and 6 months after planting (MAP) (table 5). Plant height increased in the order of control<NPK<PM<5t/ha PM+300kg/ha NPK<2.5t/ha+450kg/ha NPK. Relative to other treatments 2.5t/ha+450kg/ha NPK increased plant height significantly at 1 (site 1), 2, 3, (site2), 4 (site1), 5 and 6 (site 2) MAP.

Relative to control, the NPK, PM, 5t/ha PM+300kg/ha NPK, and 2.5t/ha PM+450kg/ha NPK increased stem girth significantly at sites 1 and 2 at 1, 2,3,4,5 and 6 MAP. stem girth increased in the stated order. Relative to the other treatments, 2.5t/ha PM+450kg/ha NPK increased stem girth significantly (table 6).

The NPK, PM, 5+/ha PM +300/g/ha NPK, and 2.5t /ha PM + 450kg/ha NPK increased leaf count per plot relative to control from l MAP at site 1 and 2. Leaf count increased in the order control, NPK, PM, 5+/ha PM+300kg/ha NPK, and 2.5t / ha PM + 450kg/ha NPK respectively. The latter treatment tended to give significant value than other treatments (table 7). The effects of the manure treatments on cassava leaf area follow the same trend as in number of leaf per plant (table 8).

Results of the effects of the different manure treatments on cassava yield are presented in table 9. Yield parameters such as tuber girth, tuber length, number of tubers and fresh tuber yield were significantly increased by NPK, PM, 5t/ha PM + 300kg/ha NPK, and 2.5t/ha PM+ 450kg/ha NPK. Among the manure and NPK treatments, the 10t/ha PM gave the least values of the yield parameters. Therefore addition of NPK to PM increased performance of cassava; and the recommended fertilizer rate of 600kg/ha was more effective than PM at 10t/ha in increasing yield of cassava. The combined application of reduced levels of NPK and PM increased the yield parameters than NPK or PM alone. The mean fresh tuber yield for the control, NPK, PM, 5t/ha PM+ 300kg/ha NPK, and 2.5t/ha PM +450kg/ha NPK were 8.6, 13.0, 11.0, 14.3 and 20.0 t/ha respectively. The values for number of tubers per plant were 4, 9.5, 6.5, 12.0 and 13.5. The values for tuber length (cm) were 22.4, 30.4, 28.5, 32.4 and 35.3cm, while values for tuber girth (cm) were 14.2, 17.5, 16.2,19.0 and 21.0 respectively. Relative to control, NPK , PM , 5t/ha PM +300kg/ha NPK, and 2.5t/ha PM + 450kg/ha NPK increased tuber yield by 34, 28,66 and 133% respectively.

4. Discussions

The soils at FUTA and FECA were acidic, low in organic matter, N, K, and Mg. The critical levels of pH and nutrient set for cassava are pH 5.2 – 7.0, 0.2% N, 7.3 mg/kg available P, 0.14-1.20 cmol/kg exchangeable K, and 3-8 cmol/kg exchangeable Mg (Howeler, 1991). The critical level of organic matter for crop production in Nigeria ecological zones were 3.0%, and the value of exchangeable Ca was 2.2 cmol/kg (Akinrinade and Obigbesan, 2000).

All manure treatments increased SOM, N, available P and exchangeable K, Ca and Mg relative to the control treatment. Analysis of the poultry manure used indicated it had considerable percentages of N, P, K, Ca and Mg; hence, nutrients released by the manure should have contributed to improving nutrient availability to cassava on the infertile soils and invariably supported higher yield. Wongwiwatchai et al. (2001) had earlier proposed that, to improve the sustainability and increase the productivity of cassava, chemical fertilizer and / or organic manures should be applied.

The combined application of PM and NPK scored best among all the treatments in terms of growth and yield performances of cassava. This is in line with findings from several researchers whose work revealed the benefit of combining organic and mineral fertilizers – as organomineral fertilizers. Kang and Balasubramanian (1990) suppoted by Babatola et al. (2002) on leafy vegetable suggested that high and sustained yield could be obtained with judicious and balanced NPK fertilizer combined with organic source of plant nutrients.

Table 3: Effects of combine application of NPK 15:15:15 fertilizer and poultry manure on soil chemical composition at site 1 (FUTA) and site 2 (FECA).

Treatments	SOM(%)		N(%)		P (Mg/kg)		K(Cmol/kg)		Ca(Cmol/kg)		Mg(Cmol/kg)		pH	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Control	0.59^{c}	0.89^{d}	0.08^{c}	7.51^{d}	6.00^{c}	0.54^{b}	0.28^{d}	0.54^{d}	3.20^{b}	4.33^{c}	1.40^{c}	1.28^{d}	5.19^{bc}	5.66^{b}
600kg/ha NPK	1.77^{b}	1.98^{c}	0.12^{b}	9.61^{d}	10.06^{c}	0.47^{a}	0.43^{c}	1.47^{a}	4.80^{ab}	5.90^{b}	1.80^{c}	1.92^{c}	4.82^{c}	4.74^{c}
10t /ha PM	2.36^{a}	4.26^{a}	0.24^{b}	11.28^{c}	11.23^{c}	0.70^{a}	0.47^{c}	1.70^{a}	5.10^{ab}	6.40^{b}	2.10^{bc}	2.78^{b}	6.16^{a}	7.16^{a}
5t/ha PM+300kg/ha	2.10^{ab}	3.49^{b}	0.20^{c}	13.50^{b}	14.49^{b}	1.76^{a}	0.63^{b}	1.76^{a}	5.90^{a}	6.93^{ab}	2.37^{2b}	3.08^{ab}	5.66^{ab}	6.09^{b}
NPK														
2.5t/ha PM+450kg/ha	2.24^{a}	4.20^{a}	0.32^{a}	15.45^{a}	18.45^{a}	1.89^{a}	0.89^{a}	1.89^{a}	6.70^{a}	7.67^{a}	3.10^{a}	3.62^{a}	5.92^{a}	6.24^{a}
NPK														

Means in a column followed by the same letter (s) are not significantly different at P<0.05

Table 4: Effects of combined application of NPK 15:15:15 fertilizer and poultry manure on cassava leaf nutrient composition at site 1 (FUTA) and site 2 (FECA).

Treatments	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	1	2	1	2	1	2	1	2	1	2
Control	4.46^{a}	4.39^{b}	1.34^{c}	1.05^{b}	4.64^{c}	4.30^{a}	7.10^{d}	5.62^{d}	3.24^{b}	2.56^{b}
600kg/ha NPK	4.5^{a}	4.84^{a}	1.96^{b}	2.10^{a}	4.94^{b}	4.66^{a}	7.66^{c}	6.32^{c}	3.35^{ab}	3.06^{a}
10t/ha PM	4.95^{a}	4.87^{a}	2.20^{ab}	2.12^{a}	4.98^{b}	4.78^{b}	7.81^{bc}	6.56^{c}	3.69^{a}	3.16^{a}
5t/ha PM+300kg/ha	4.99^{a}	4.90^{a}	2.22^{a}	2.22^{a}	5.15^{ab}	5.98^{a}	8.22^{ab}	7.21^{b}	3.72^{a}	3.26^{a}
NPK										
2.5t/ha PM+450kg/ha	5.16^{a}	5.16^{a}	2.31^{a}	2.23^{a}	5.26^{a}	5.11^{a}	8.40^{a}	8.06^{a}	3.76^{a}	3.32^{a}
NPK										

Means in a column followed by the same letter (s) are not significantly different at P<0.05

Table 5: Effects of combined application of NPK 15:15:15 fertilizer and poultry manure of cassava plant height (cm) site 1 (FUTA) and site 2(FECA).

Treatment	1 MAP		2 MAP		3 MAP		4 MAP		5 MAP		6 MAP	
	1	2	1	2	1	2	1	2	1	2	1	2
Control	10.60^{c}	15.61^{c}	29.00^{d}	55.00^{c}	70.75^{d}	86.13^{c}	105.79^{d}	123.30^{d}	134.67^{c}	138.06^{c}	152.96^{c}	143.27^{d}
600kg/ha NPK	12.26^{b}	16.34^{b}	38.72^{c}	62.29^{d}	74.09^{c}	96.59^{d}	125.79^{c}	138.65^{c}	168.92^{d}	151.01^{d}	186.13^{b}	163.33^{c}
10t/ha PM	12.73^{b}	17.09^{ab}	42.70^{b}	66.80^{c}	76.25^{b}	100.04^{c}	128.92^{b}	143.25^{b}	173.48^{c}	156.48^{c}	197.75^{a}	164.57^{c}
5t/ha PM+	12.92^{b}	17.80^{a}	42.89^{b}	70.92^{b}	86.63^{a}	108.00^{b}	130.12^{b}	149.21^{c}	180.88^{b}	162.34^{b}	199.49^{a}	174.36^{b}
300kg/ha NPK												
2.5t/ha PM +	14.83^{a}	18.00^{a}	45.66^{a}	73.63^{a}	87.09^{a}	110.13^{a}	135.63^{a}	150.54^{d}	190.50^{a}	169.53^{a}	199.92^{a}	177.49^{a}
300kg/ha NPK												

Means in a column followed by the same letter (s) are not significantly different at P<0.05
MAP: Month after planting

Table 6: Effects of combined application of NPK 15:15:15 and poultry manure on cassava stem girth (cm) at site 1 (FUTA) and site 2(FECA).

Treatment	1 MAP		2 MAP		3 MAP		4 MAP		5 MAP		6 MAP	
	1	2	1	2	1	2	1	2	1	2	1	2
Control	1.69^{c}	2.25^{b}	3.10^{c}	4.71^{c}	5.92^{b}	5.25^{c}	6.88^{c}	6.51^{c}	7.21^{c}	6.72^{c}	7.63^{c}	6.88^{d}
600kg/ha NPK	1.82^{bc}	3.10^{a}	3.50^{bc}	6.38^{b}	6.13^{ab}	6.88^{b}	7.38^{c}	7.69^{b}	7.88^{bc}	7.99^{b}	8.67^{b}	8.15^{c}
10t/ha PM	1.94^{abc}	3.15^{a}	3.90^{b}	6.72^{ab}	6.13^{ab}	7.50^{ab}	7.92^{ab}	8.42^{a}	8.17^{bc}	8.67^{ab}	8.92^{a}	8.69^{c}

5t/ha PM+	1.99^{ab}	3.21^{a}	4.06^{b}	6.92^{b}	6.25^{ab}	7.75^{a}	8.03^{ab}	8.64^{a}	8.92^{ab}	8.78^{ab}	8.96^{b}	9.32^{b}
300kg/ha NPK												
2.5t/ha PM +	2.15^{a}	3.25^{a}	4.76^{a}	7.08^{a}	6.48^{ab}	7.80^{a}	8.51^{a}	8.99^{a}	9.63^{a}	9.46^{a}	8.87^{a}	10.42^{a}
450kg/ha NPK												

Means in a column followed by the same letter (s) are not significantly different at P<0.05
MAP: Month after planting.

Table 7: Effects of combination application of NPK 15:15:15 fertilizer and poultry manure of leaf per plant at site 1 (FUTA) and site 2(FECA).

Treatment	1 MAP		2 MAP		3 MAP		4 MAP		5 MAP		6 MAP	
	1	2	1	2	1	2	1	2	1	2	1	2
Control	6^{b}	7^{d}	20^{c}	28^{c}	39^{d}	34^{c}	75^{d}	58^{d}	113^{c}	63^{c}	101^{d}	54^{c}
600kg/ha NPK	8^{ab}	8^{cd}	24^{b}	33^{b}	45^{c}	39^{b}	93^{c}	66^{c}	150^{c}	69^{b}	109^{c}	638^{b}
10t /ha PM+	9^{a}	10^{bc}	27^{a}	33^{b}	46^{bc}	41^{b}	96^{c}	68^{bc}	156^{a}	72^{ab}	112^{c}	68^{a}
5t/ha PM+	9^{a}	12^{ab}	27^{a}	35^{ab}	50^{ab}	45^{a}	106^{b}	70^{a}	157^{a}	73^{ab}	119^{b}	69^{a}
300kg/ha NPK												
2.5t/ha PM +	10^{a}	13^{a}	28^{a}	37^{a}	52^{a}	48^{a}	117^{a}	73^{a}	159^{a}	76^{a}	125^{a}	72^{a}
450kg/ha NPK												

Means in a column followed by the same letter (s) are not significantly different at P<0.05
MAP: Month after planting

Table 8: Effects of combined application of NPK 15:15:15 fertilizer and poultry manure on cassava leaf area (cm^2) at site 1 (FUTA) and site 2(FECA).

Treatment	1 MAP		2 MAP		3 MAP		4 MAP		5 MAP		6 MAP	
	1	2	1	2	1	2	1	2	1	2	1	2
Control	41.9^{d}	74.9^{b}	83.3^{e}	116.3^{d}	99.8^{d}	111.8^{d}	103.6^{c}	101.5^{d}	99.6^{c}	100.4^{b}	87.9^{c}	97.3^{d}
600kg/ha NPK	49.4^{c}	80.4^{a}	94.2^{b}	137.5^{c}	105.9^{c}	127.8^{c}	110.5^{c}	107.5^{c}	110.1^{b}	105.1^{a}	92.0^{d}	98.6^{c}
10t/ha PM	51.0^{bc}	81.8^{b}	98.1^{c}	141.0^{b}	110.0^{b}	128.3^{c}	109.3^{b}	109.3^{b}	110.5^{b}	106.1^{a}	94.4^{c}	100.8^{b}
5t/ha PM+	52.8^{ab}	82.0^{b}	100.5^{b}	142.3^{b}	110.8^{b}	130.9^{b}	109.4^{b}	109.4^{b}	111.0^{b}	106.7^{a}	96.5^{b}	105.2^{a}
300kg/ha NPK												
2.5t/ha PM +	54.5^{a}	83.5^{a}	105.5^{a}	152.3^{as}	115.1^{a}	138.5^{a}	115.9^{a}	115.9^{a}	118.7^{a}	108.6^{a}	99.1^{a}	105.6^{a}
450kg/ha NPK												

Means in a column followed by the same letter (s) are not significantly different at P<0.05
MAP: Month after planting.

Table 9: Effects of combined application of NPK 15:15:15 fertilizer and poultry manure on yield components of cassava at site 1 (FUTA) and site 2(FECA).

Treatment	Tuber girth (cm)		Tuber girth (cm)		No of tubers/plant		Fresh tuber weight (kg/plant)		Fresh tuber yield (t/ha)	
	1	2	1	2	1	2	1	2	1	2
Control	14.2^{b}	14.9^{d}	22.4^{d}	25.8^{c}	5^{d}	3^{e}	5.9^{c}	7.9^{c}	7.4^{c}	9.8^{c}
600kg/ha NPK	17.5^{ab}	17.4^{c}	30.4^{a}	31.4^{abc}	9^{c}	10^{c}	9.8^{b}	11.1^{bc}	12.2^{b}	13.9^{bc}
10t/ha PM	15.93^{ab}	16.6^{c}	28.5^{a}	30.0^{ab}	7^{c}	6^{d}	7.8^{bc}	9.9^{bc}	9.7^{bc}	12.3^{bc}
5t/ha PM+	19.0^{ab}	19.0^{b}	32.4^{a}	32.3^{b}	11^{b}	13^{b}	10.8^{b}	12.0^{b}	13.5^{b}	15.1^{b}
300kg/ha NPK										
2.5t/ha PM +	21.07^{a}	20.9^{a}	35.3^{a}	36.3^{a}	12^{a}	15^{a}	14.5^{a}	17.4^{a}	18.2^{a}	21.8^{a}
450kg/ha NPK										

Means in a column followed by the same letter (s) are not significantly different at P<0.05
MAP: Month after planting.

Ipinmoroti et al. (2002) also indicated that quick mineralization of inorganic component and the slow nutrient release of the organic constituents of organominerals must have sustained the continuous better performance of *A. cruentus* than their separate applications. Complementary use of organic manures and mineral fertilizers has also been proved to be a sound soil fertility management strategy in many countries of the world (Lombin et al., 1991). Santhi and Selvakumari (2000) have proposed that the addition of organic sources to chemical fertilizer could increase the yield through improving soil productivity and higher fertilizer use efficiency, while Ayoola and Makinde (2007) also suggested that an integrated nutrient management program, in which both organic manure and inorganic fertilizer are used, is a rational strategy. The combined use will increase synchrony and reduce losses by converting inorganic N into organic forms (Kramer *et al.,* 2002). It also reduces the environmental problems that may arise from the use of sole inorganic fertilizers and improves the microbial properties of the soil (Belay *et al.,* 2001). There are evidences from field research that high and sustainable yields are possible with integrated use of fertilizers and manure (Bayu *et al.,* 2006).

SOM was found to be highest with application of PM at 10t/ha and lowest in plots treated with NPK at 600kg/ha. Analysis of soil samples previously treated with varying levels of PM and NPK fertilizers, and bioassay experiment conducted on the same soils by Adenawoola and Adejoro (2005) revealed that Organic matter and soil nutrients increased with application rate of Poultry manure. They further discovered that the growth and yield of *C olitorius* were still significantly improved even a year after application of PM, whereas, NPK fertilizer had no significant residual effects on soil fertility and yield of *C olitorius.*

The values of residual N, P, K and Mg were highest in plots treated with sole application of PM. This was closely followed by combined applications of PM and NPK and the least figures were recorded with sole application of NPK at 600kg/ha. Application of poultry manure has various advantages such as increasing soil physical properties, water holding capacity, and organic carbon content apart from supplying good quality of nutrients (Ayoola and Adeniyan, 2006). Nuttidge et al. (2005a) also discovered that incorporated wood ash and peanut residue were effective in improving N, P, CEC and physical properties of Ultisols of Southeast Nigeria, that combination of these materials was more effective than sole use of each of them, and also that the materials improved soil physical properties more than NPK fertilizers.

Soil pH increased with application of PM at 10 t/ha and decreased with sole application of NPK at 600 kg/ha. This further establishes the findings of Adeniyan et al. (2011) that organic manures have greater potential of raising soil pH compared to NPK fertilizer, and suggested that organic manures could serve as good amendment materials in ameliorating acid soils. It also corroborates the assertion by Nuttidge et al. (2005a), that the use of chemical fertilizers has not been able to sustain high productivity due to enhancement of soil acidity, leaching and degradation of soil organic matter and physical conditions.

Application of 5t/ha PM+300kg/ha NPK and 2.5t/ha PM+ NPK fertilizer tended to give relatively higher leaf nutrient concentration. This may be due to the fact that nutrients were higher in the plots that received these treatments and were available for crop uptake.

5. Conclusion

This paper has clearly demonstrated that despite the fact that application of either poultry manure or NPK fertilizer will increase cassava growth in the alfisols soils of southwestern Nigeria, the combination of their reduced levels should be preferred as they tended to score best in terms of residual soil nutrient availability, cassava leaf nutrient composition and cassava growth parameters. They also maximized cassava yield significantly in this study. They may therefore be recommended for high performance as well as sustainable cultivation of the crop.

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