Nigerian Journal of Soil Science 23 (2013) 276 – 281

Nigerian Journal of Soil Science

Journal homepage:www.soilsjournalnigeria.com

NUTRIENTS CONCENTRATION AND ROOT COUNT OF CASSAVA AS INFLUENCED BY RESIDUE AND NPK FERTILIZER

Babadele, D.O. and Ojeniyi, S.O.

Department of Crop Soil and Pest Management,

Federal University of Technology P.M.B. 704 Akure, Nigeria.

ABSTRACT

Experiment was conducted at two sites Ayegunle and Oka in South-West Nigeria to study effect of combined plant residues sawdust ash (SDA) and siam weed (Chromolaena odorata) (CR) and NPK (15:15:15) fertilizer on leaf N, P, K, Ca and Mg of Cassava. The parameters were evaluated at 3,6,9 and 12 months after planting (MAP) for nutrient concentrations and root count of cassava. The test soils are sandy loan and slightly acidic. Treatments replicated three times on cassava plants were (a) control, (b) 4t/haSDA+10t/haCR, (c) 400 kg/ha NPKF, (d) 4t/haSDA + 10t/haCR + 100kg/ha NPK F, (e) 4t/haSDA + 10t/ha CR +200kg/ha NPKF, (f) 4t/haSDA + 10t/ha CR + 300 kg/ha NPKF. The residues and NPKF, sole or combined significantly increased leaf N,P,K,Ca and Mg and number of roots at the four periods of determinations. Compared with NPKF, plant residues alone or combined with NPKF increased with rate of NPKF. Combination 4t/haSDA-10t/haCr+300kg/ha NPKF gave highest values of the measured parameters at 3, 6, 9 and 12 MAP. At 12 MAP its root count was higher by 109% compared with 400kg NPKF. Nutrients concentrations were higher at 9 and 12 MAP.

INTRODUCTION

Cassava (Manihot esculenta, Grantz) products are energy rich foods widely consumed in different forms in sub-Sahara Africa and tropical countries. In Nigeria, the government's drive for increased revenue from export of cassava led to a great need to increase its production. Cassava is grown primarily for edible carbohydrate. The tubers are eaten raw, boiled, fried, or in baked foods. Starch from cassava is used in food and textile industries as well as in pharmaceutical and rubber sectors. Its leaf also has a considerable amount of protein. Also cassava flour is used as a partial substitute for wheat flours (Odedina et al, 2012).

However the growth environment for cassava in most fields in Africa receives little additional soil nutrients from manures or fertilizers, hence its yield (Asadu et al, 1998) and nutrients content are adversely affected. Almost no farmer buys fertilizer for cassava production (Odedina et al 2012). Cassava depletes soil nutrients because of large quantities removed with harvested roots. It was indicated by Gichuru (1991) that cassava has much higher N and P and K requirements than many other crops.The major factor against the use of inorganic fertilizer by cassava grower is its high cost and scarcity(Odedina et al, 2012). In the study by Morafa cited Odedina et al, 2012) it was found that input cost of inorganic fertilizer was higher than that of organic fertilizer, and the marginal rate of return was less for inorganic fertilizer. Hence there is serious need to study the role of integrated nutrient application in cassava production.

The key to sustainable soil fertility management in tropical agriculture is combined application of organic and organic fertilizers. Efforts in this direction will ensure build-up of soil productivity, reduction in need for both fertilizer sources, balanced plant nutrition, enhancement of crop growth, yield and nutritional quality (Ojeniyi, 2012). Integrated plant nutrition (IPN) will also assist in environmental sanitation by utilizing farm, human, domestic and municipal works. It is a waste to wealth technology. Compared with inorganic fertilizers, IPN ensures more residual effect and overall development of soil physical, chemical and biological qualities (Ayeni, 2009).

Research information is scarce on influence of integrated application of plant wastes and inorganic fertilizers in cassava production. The combined application of animal manures and NPK fertilizers has been successfully studied in cassava production (Odedina et al, 2012). This work studied effect of combined application of sawdust ash, siam weed (Chromolaena odorata) residues and NPK fertilizer on root yield, tissue N, P, K, Ca and Mg concentrations of cassava at two sites in Southwest Nigeria.

MATERIALS AND METHOD

Experimental Site

Experimental was conducted at Ajegunle and Oke-Oka in the forest savannah zone at latitude and longitude 3^0 30'N', 4^0 22'E', and 4^0 60'N', 3^0 30'E' respectively. The soils at the two sites are sandy loam alfisol which had been left under fallow for at least 10 years. Manual clearing was done before heaps were made at 1 x 1m to give 10000 cassava stands per hectare.

Treatments

Treatments replicated three times on cassava were (a) control (b) 4t/ha sawdust ash (SDA) + 10t/ha Chromolaena residue (CR), (c) 400 kg/ha NPK fertilizer (15:15:15) (NPKF), (d) 4t/ha SDA + 10t/ha CR + 100 kg/ha NPKF, (e) 4t/ha SDA + 10t/ha CR + 200kg/ha NPKF, (f) 4t/ha SDA + 10+/ha CR + 300 kg/ha NPKF. Treatments were allocated to cassava plants using a randomized complete block design each of 18 plots in each site was $48m^2$. Cassava sticks each 30cm long was planted on heaps in July 2011. The SDA and NPKF were applied on soil surface by ring method and mulched with chromolaena residues two months after planting.

Yield determination

Two plants were randomly selected and destructively sampled per plot for determination of root count per plant at 3, 6, 9 and 12 MAP (months after planting).

Leaf nutrient determination

Tissue analysis was done at 3, 6, 9 and 12 MAP. At each sampling, leaves were taken from the appropriate plants and plots. Samples were oven dried for 48hr at 65^0C and ground to pass a 0.5mm pore size sieve. Nitrogen was determined using the Kjeldahi method. The ground sample was digested with nitric-perchloric acid mixture. Phosphorus was determined by vanadomolybdate colorimetry method, K by flame photometer, and Ca and Mg by EDTA titration. Residue analysis was done. Crop data were subjected to analysis of variance and Duncan multiple range test (P = 0.05) was used for comparing treatment means.

RESULT

Nutrient analysis for sawdust ash (SDA) and chromolaena residue is showing Table 1. Ash b lower in N and P, while it is clearly higher in K, Ca, and Mg. The two materials will complement each other and ensure balanced release of nutrient to Cassava.

Data of tissue nutrient analysis are shown in Table 2 for N, table 3 for P, table 4 for K, table 5 for Ca and table 6 for Mg. Relative to control, combined application of residues (SDA + CR), sole NPKF and combined application of residues with NPKF at reduced rates increased tissue N, P, K, Ca and Mg of cassava at 3, 6, 9 and 12 MAP.

Compared with sole NPKF (400kg/ha), combination of reduced levels of NPKF (100, 200 and 300 kg/ha) with plant residues increased leaf N, P, K, Ca, of cassava at 9 and 12 MAP (harvest periods). In case of Mg the increases were observed at 3, 6, 9, and 12 MAP.

The leaf N, P, K, Ca and Mg increases with rate of NPKF applied with the plant residues at 3, 6, 9 and 12 MAP.

The combination 4t/ha SDA + 10t/ha CR + 300Kg/ha NPKF gave highest values of leaf N, P, K, Ca and Mg at 3, 6, 9, and 12 MAP. It also gave highest concentration of leaf Ca at 3, 9 and 12 MAP.

Table 1: Analysis of Sawdust ash (*SDA) and Chromolaena residue (CR)

Property (%)	SDA	CR
N	0.27	2.40
P	0.10	0.35
K	5.80	2.50
Ca	1.50	0.49
Mg	0.48	0.40

Table 2: Effect of Chromolaena residue (CR) plus sawdust (SDA) and NPK Fertilizer (NPKF)

	Months after Planting				
Treatment	3	6	9	12	
Control	2.52c	3.22b	3.38c	4.60c	3.43
4t/ha SDA + 10t/ha CR	2.72c	3.28b	3.61c	4.95b	3.64
400 Kg/ha NPKF	3.26a	3.85a	3.87c	4.90b	3.97
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	2.89b	3.5a	4.1b	5.05a	3.90
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	3.07b	3.6	4.38b	5.12a	4.05
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	3.14a	3.75a	4.92a	5.49b	4.32

Values with same letter in a column are not significantly different (P = 0.05)

Table 3: Effect of Chromolaena residue (CR) plus sawdust ash (SDA) and NPK Fertilizer (NPKF) on Cassava leaf P (mg/kg)

	Months after Planting			
Treatment	3	6	9	12
Control	14.4b	14.4c	22.9c	18.6d
4t/ha SDA + 10t/ha CR	15.9b	19.3b	26.1b	20.0d
400 Kg/ha NPKF	20.0a	24.3a	27.3b	32.7c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	17.7a	20.8a	28.2b	21.0b
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	18.1a	22.0a	29.8b	21.5c
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	19.9a	22.3a	32.5a	24.4b

Leaf samples combined for the two sites.

Table 4: Effect of Chromolaena residue (CR) plus sawdust ash (SDA) and NPK Fertilizer (NPKF) on Cassava leaf K (mg/kg)

	Months after Planting			
Treatment	**3**	**6**	**9**	**12**
Control	4.8e	4.5c	6.0e	4.3c
4t/ha SDA + 10t/ha CR	5.3d	4.8c	7.0d	4.9b
400 Kg/ha NPKF	7.3a	6.9a	7.4cd	4.8b
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	5.7d	5.3b	7.8c	5.0a
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	6.2c	5.7b	8.2b	5.2a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	6.8b	6.1b	9.1b	5.3a

Values in a column followed by same letters are not significant different (P=0.05).

Table 5: Effect of Chromolaena residue (CR) plus sawdust ash (SDA) and NPK Fertilizer (NPKF) on Cassava leaf Ca (mg/kg)

	Months after Planting			
Treatment	**3**	**6**	**9**	**12**
Control	4.8b	17.7d	17.8c	17.9c
4t/ha SDA + 10t/ha CR	5.3b	19.2c	18.4b	19.1b
400 Kg/ha NPKF	20.2a	18.4c	18.1b	18.4c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	18.3a	20.1b	18.8b	19.4b
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	19.0a	20.9b	19.7a	20.0a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	19.8a	24.6a	20.4a	20.8a

Values in a column followed by the same letters are not significantly different (P=0.05)

Table 6: Effect of Chromolaena residue (CR) plus sawdust ash (SDA) and NPK Fertilizer (NPKF) on Cassava leaf mg(mg/kg)

	Months after Planting			
Treatment	**3**	**6**	**9**	**12**
Control	3.6d	4.5e	4.0c	4.4c
4t/ha SDA + 10t/ha CR	4.3c	5.3d	4.9d	5.1b
400 Kg/ha NPKF	5.8a	4.8e	4.6c	4.7c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	4.7c	6.0c	5.3b	5.3b
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	4.8b	7.1b	5.5b	5.9a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	5.1b	7.7a	5.2a	6.0a

Means followed by the same letter in a column are not significantly different (P=0.05).

Table 7: Number of Cassava roots as influenced by Plant residues and NPK Fertilizer at Ayegunle (AY) and Oka (OK)

Treatment	**3 MAP**		**6 MAP**		**9 MAP**		**12 MAP**	
	AY	**OK**	**AY**	**OK**	**AY**	**OK**	**AY**	**OK**
Control	13.7b	9.0c	8.0c	10.3d	4.7d	4.0c	5.7b	4.3c
4t/ha SDA + 10t/ha CR	16.0b	12.7bc	11.0bc	12.0c	8.0cd	8.0bc	9.3ab	6.7bc
400 kg/ha NPKF	24.3a	20.7a	12.7b	12.3c	7.0cd	7.0bc	7.3ab	5.3c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	17.7ab	13.0bc	14.0b	14.3b	10.6bc	9.3ab	11.0ab	8.0b
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	19.0ab	14.7bc	15.3ab	15.0ab	13.6ab	10.0ab	12.3ab	11.7a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	20.0ab	16.3ab	19.7a	16.3a	18.0a	13.7a	21.3a	14.0a

A=Sawdust ash, CR= Chromolaena residue:Values in a column followed by the same letter are not significant different (P=0.05)

Generally leaf N, P, K and Ca increased it 9 MAP and values for 9 and 12 MAP were similar.

The residues, NPKF and their combinations increased number of roots at 3, 6, 9 and 12 MAP at Ayegunle and Oke-Oka (Table 7). At 3 and 6 MAP, NPKF increased number of roots compared with residues, whereas at 9 and 12 MAP residues had higher values of number of roots. The number of roots increased with rate of NPKF between 100 and 300 kg/ha combined applications of residues with NPKF increased number of roots relative to NPKF. The 4t/ha SDA + 10t/ha CR + 300kg/ha NPKF which had highest values of leaf nutrients had highest values of root count at 3,6,9 and 12 MAP and at the two study sites. At 12 MAP, it increased root count by 109% relative to sole NPKF.

DISCUSSION

It was found that plant residue alone or combined with NPK fertilizer significantly increased leaf N, P, K, Ca, Mg and number of roots. The responses are consistent with earlier finding (Babadele and Ojeniyi, 2012) that the soils were slightly acidic at Ayegunle and Marginal in OM and Nt Oke Oka. Therefore it is indicated that the two materials improved nutrient availability in soil and uptake of these nutrients leading to increase in cassava yield. This statement is further confirmed by the finding that leaf N, P, K, Ca and Mg increased with rate of NPKF, and that plant residues such as sawdust and chromolaena residue increased the plant nutrients and root count. The increases in plant nutrients due to use of NPKF alone is attributable to the fact that the fertilizer increased root growth, hence the nutrients uptake. Fertilizer experiments carried out in different parts of Nigeria confirmed positive response of cassava yield to N, P, and K fertilizers (Agbaje and Akinlosotu, 2004 Adekayode and Adeola 2009).

The improved nutrient contents and of cassava yield associated with plant residue such as sawdust and chromolaena residue can be adduced to the previous findings that the materials contained macro nutrients and organic matter (Ojeniyi and Adejobi 2002, Ojeniyi and Igbomrore, 2004, Akanbi and Ojeniyi, 2007; Awodun and Ojeniyi, 1988: Ayeni et al, 2008, Ojeniyi et al, 2012) and were effective in improving yield of crops such as amaranthus, maize, yam and cassava.

The combination 4t/ha SDA + 10t/ha CR + 300 kg/ha NPKF most increased plant nutrients content at 3, 6, 9 and 12 MAP and thus gave highest root count. The combination reduced need for fertilizer by 25%. This finding supports the application of integrated nutrient supply in cassava production. Nutrient release from organic courses is slow and may not meet the need of crop at the point of maximum need for growth. Hence combination of organic and inorganic sources assists to synchronize nutrients release for crop growth. It is found in this work that treatments involving combination of plant residues with reduced rates of NPKF had highest root count consistently.

Also the use of plant residues with organic fertilizer ensured residual effect on nutrient uptake compared with fertilizer alone. At the 9 and 12 MAP, integrated application of residues and NPK gave higher plant N and P (except at 12 MAP), K, Ca and Mg concentrations relative to NPKF alone.

CONCLUSION

Plant residues such as siam weed and sawdust combined with NPK fertilizer were effective sources of plant nutrients and could be used for sustaining soil fertility and productivity in cassava production. The combination reduced need for inorganic fertilizer by 25% and increased root count by 109% relative to NPK fertilizer.

REFERENCES

Adekayode, F.O. and O.F. Adeola. 2009. The response of cassava to potassium fertilizer treatments. Journal of Food Agriculture and Environment 7(2), 279-282.

Agbaje, G.O. and Akinlosolu, T.A. 2004 Influence of NPK fertilizer on tuber yield of yearly and late planted cassava in a forest alfisol Biotechnology 3(10), 547-551.

Akanbi, O.S. and Ojeniyi, S.O. 2007. Effect of Siam weed on soil properties and performance of yam in Southwest Nigeria. Nigerian Journal of Soil Science 17, 120-125.

Asadu, C.L.A., Nweke, F.I. and Ekanayake, I.J. (1998). The fertility status of soils grown to Cassava in Sub-Saharan Africa. Communications in Soil Science and Plant Analysis 29; 141-159.

Awodun, M.A. and S.O. Ojeniyi 1998. Use of weed mulches for improving soil fertility and maize performance. Applied Tropical Agriculture 3, 26-30.

Ayeni, L.S, Adetunji, M.T, Ojeniyi, S.O, Ewulo, B.S. and Adeyemo, A.T 2008 a Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and maize nutrients content and yield of maize American Eurasian. Journal of Sustainable Agriculture 2(1), 92-97.

Ayeni, L.S., Ayeni, O.M., Oso, O.P. and Ojeniyi, S.O. 2008b.Effect of sawdust and woodash applications in Improving soil chemical properties and growth of cocoa seedlings in the Nurseries. Agricultural Journal 3(5), 323-326.

Babadele, D.O. and Ojeniyi, S.O. 1212. Effects of organic wastes on soil and plant nutrient content and yield of cassava (Manihot esculenta Crantz). Nigerian Journal of Soil Science 22(2), 112-118

Gichuru, M.P. 1991. Residual effects of natural bush Cajanus cajan and Tephrosia candida on the productivity of an acid soil in southeastern Nigeria. In: Wright R.J. et. al (Ed.) Plant soil interactions at low pH. Dordrecht (The Netherlands): Kluver Academics Publishers P. 417-422.

Odedina, J., Ojeniyi, S.O. and Odedina, S. 2012. Integrated Nutrient Management for sustainable cassava production in Southwestern Nigeria. Archives of Agronomy and Soil Science 58 (Supp. 1), 132-140.

Ojeniyi, S.O. and Igbomrore, H. 2004. Comparative effect of mulches on soil and leaf nutrient content and cassava yield. Nigerian Journal of Soil Science 14, 93-97.

Ojeniyi, S.O. and K.B. Adejobi. 2002. Effect of ash and goat dung manure on leaf nutrients composition growth and yield of amaranthus, Nigeria Agriculture Journal 33, 46-57.

Ojeniyi, S.O. 2012. Advances in Integrated nutrient management for crop production in Nigeria. Nigerian Journal of Technological Research 7, 39-43.