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CASSAVA YIELD AS AFFECTED BY SAWDUST ASH SIAM WEED RESIDUE AND NPK FERTILIZER

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ABSTRACT

Experiment was conducted at Ayegunle and Oka South-West Nigeria to study effect of combined sawdust ash and siam weed residues and NPK fertilizer (NPKF) on soil nutrients and performance parameters of cassava. Plant parameters determined were number of leaves, plant height, stem girth, leaf area index, root weight, root diameter and root length. Plant residues NPKF and their combinations increased significantly soil OM, N, P, K, Ca, Mg and cassava performance parameters. NPKF at 400kg/ha reduced soil pH and gave least values of soil nutrients among treated soils, and OM and pH reduced with increased with rate of NPKF. Combinations of residues and NPKF increased soil pH, OM, N, P, K, Ca and Mg and cassava performance compared with NPKF. Performance parameters increased with rate of NPK when it is combined with residues. The 4t/ha SDA+10t/ha CR+300kg/ha gave highest values of cassava performance parameters and soil N,P.K, Ca and Mg.

INTRODUCTION

Cassava (Manihot esculenta, Crantz) is a major staple in the tropics where it is produced for domestic direct consumption and industrial use. Cassava flour is added as a component for baking break and biscuits, it is also a source of starch. In some nations it is used to produce ethanol which is mixed with gasoline in the production of gasohol for fueling vehicles. The mixture is known to reduce carbon-dioxide emission during automobile use thereby improving air quality and reducing global warming (Adekayode and Adeola, 2009). According to Ene-Okoro et al (1999) cassava offers about 58% of food consumed by human beings and 28% feed consumed by domestic animals.

But due to increasing population and resultant intensification of Agriculture, low soil fertility has adversely affected cassava yield. Because of high cost cassava farmers do not apply chemical fertilizers but depend on organic sources of plant nutrients (Odedina et al, 2012, Nottidge et al, 2007). Continuous use of chemical fertilizer has been found to reduce soil base saturation increase acidification and cause soil physical degradation (Ojeniyi, 2012).

According to Lal (1986) the use of organic wastes as fertilizers is especially important for small holders who neither can afford commercial fertilizers nor are sure of their effectiveness. Also combined application of organic and inorganic nutrient sources in crop production has been shown to be the sustainable method of soil fertility maintenance. Integrated nutrient application has been found to be more effective than use of either of the two sources in maintaining high crops yield and soil fertility (Ojeniyi, 2012: Ojeniyi et al 2012, Adeniyan and Ojeniyi, 2003, 2005) even in cassava production (Ojeniyi et. al. 2012, Odedina et. al. 2012).

Research information is rare on effect of combined application of mixed plant residues and inorganic fertilizers in cassava production. This work investigated effects of combination of plant residues such as sawdust ash and siam weed residues and NPK fertilizer on soil nutrients composition and yield components of cassava. The study is expected to determine the suitability of the materials and their ability to reduce the need for chemical fertilizers in cassava production.

MATERIALS AND METHOD

Experimental Site

Experiments was conducted at two locations Ayegunle and Oke-Oka in the forest Savanah ecological 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 are Alfisol, sandy loam, flat and well drained, and had been left fallow before heaps were made. Clearing was done before heaps were made at 1m x 1m to give 10000 stands per hectare.

Treatments

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

Soil analysis

In each study site, samples were taken using 5mm auger to 0-30cm depth over each site and after experiment in each treatment plot. They were bulked air – dried and 2mm – sieved for routine analysis. Particle size analysis was done by Bouyoucos method, pH was determined in 1:2.5 soil / water suspension using glass electrode, organic matter was determined by wet dichromate oxidation method, total N was determined by Kjeldahl digestion followed by colorimetry, available P was extracted using Bray – P1 solution and determined using molybdenum blue colorimetry, exchangeable bases were extracted using ammonium acetate, Ca and Mg were determined using atomic absorption spectrophotometer and K using flame photometer.

Growth and Yield determination

Growth and yield characteristics measured at 3, 6, 9 and 12 months after planting (MAP) included plant height, stem girth, lea area index (LAI), shoot fresh weight, root fresh weight, number of roots, root diameter and length. Six plants were selected in the middle rows of each plot for growth evaluation (Ekanayake, 1993). Two plants were selected randomly and destructively sampled per plot for determination of shoot weight, number of roots, root diameter and length at 3,6, and 9 MAP. A net plot sized $16m^2$ was created at harvest (12 MAP) and all appropriate measurements were taken within it. Tuber yield was converted to ha basis, leaf area index (LAI) was measured using Hammer's equation Y = 6.11 X L,, Y being leaf area, L length of midrib of central lobe. Six plants were selected for the measurements. Twenty leaves were selected per plant and later converted to leaf area per plant using:

LAI = Area of 1 leaf + Total Number of leaves per plant
Planting space per plant

Data Analysis

The crop data were subjected to analysis of variance and Duncan multiple range test (P = 0.05) was used to compare the treatment means.

RESULT AND DISCUSSION

Tables 1 and 2 show data on soil chemical analysis as influenced by application of plant residues, NPK fertilizer (NPKF) alone and their combinations. The materials alone or combined increased soil OM, N, P, Ca and Mg at Ayegunle and Oka sites significantly. At Ayegunle combinations of sawdust ash (SDA) plus chromolaena residue (CR) and NPKF at 200 and 300 kg/ha also increased soil K significantly. At Oka in addition to the three treatments, combination of 100 kg/ha NPKF with the residues also increased K. Compared with control and other treatments, NPKF reduced soil pH indicating it increased soil acidity which is attributable to its N and P components. Also NPKF had least values of soil OM, N, P, Ca and Mg among treated plots. This confirms that the organic wastes are effective sources of nutrients. Analysis of SDA and CR given by Babadele and Ojeniyi (2012) indicated that the materials respectively had 0.27 and 2.4% N, 0.10 and 0.35% P, 5.8 and 2.5% K, 1.5 and 0.49% Ca and 0.48, 0.40% Mg. Among the three combined treatments, soil pH and OM tended to reduce with increase in NPKF from 100 to 300 kg/ha indicating that soil acidity was increased with increased rate of NPKF. Also OM reduced with NPKF rate indicating that the chemical fertilizers increased decomposition and mineralization of organic matter. The increased mineralization is confirmed by increases in soil nutrients.

It is observed that at both study sites, treatments involving combinations of plant residues and NPKF generally increased soil OM, pH, N, P, K, Ca and Mg compared with NPKF alone. They returned base nutrients to the soil.

Treatment 4t/ha SDA + 107/ha CR + 300 kg/ha NPKF gave higher soil N, P, K, Ca and Mg at both sites of study. This is consistent with the observation that 4t/ha SDA tended to give higher values of soil N, P, K, Ca, Mg than 2t/ha SDA, while the nutrients also increased with rate of NPKF between 100 to 300 kg/ha. Therefore the treatment combined the attributes of highest rate of combined NPKF and higher release of nutrients from 4t/ha SDA compared with 2t/ha SDA.

Data on performance parameters taken at 3,6,9 and 12MAP at Ayegunle and Oka sites are shown in Table 3 for plant height, Table 4 number of leaves, stem girth (Table 5), leaf area index (Table 6), fresh shoot weight (Table 7), root weight (Table 8), and root diameter (Table 9)and root length (Table 10) Plant residues used alone, NPKF and their combined applications significantly increased the performance parameters at every period of determination. Treatments involving residues with NPKF increased the parameters significantly compared with NPKF alone. The parameters generally increased with increase in rate of NPKF applied with residue. Hence 4t/ha SDA + 10t/ha CR + 300kg/ha NPK had highest values of the growth and yield parameters. It is observed that at 3MAP, NPFK produced the higher values of the parameters, whereas at the 6, 9 and 12 MAP and at both sites, combined applications of residue and fertilizer gave higher values compared with NPKF. This suggests that nutrients such as N, P and K were more quickly available from the inorganic fertilizer, whereas the slowly released nutrients from organic sources led to greater performance of cassava in later months which led to cumulative effect on yield at 12 MAP. The residues alone also had higher values of growth and yield parameters compared with NPKF at 12 MAP.

Generally performance parameters such as plant height, numbers of leaves, stem girth, root weight, root length, stem girth, and root diameter increased with months, especially between 6 and 12 MAP. The increase in tuber yield is attributable to increased bulking of cassava roots due to availability of carbohydrate translocated from the increasing leaves. However leaf area index (LAI) reduced at 6 and 9. MAP because the periods corresponded to the dry period of the year. The LAI was generally least at 9 MAP which fell in the most dry period (March).

The higher values of performance parameters recorded for combinations of plant residues and NPKF are consistent with higher values of soil nutrients for the treatments. Relative to the control, 4t/haSDA + 10t/ha Cr, 400kg/ha NPKF, 4t/ha SDA + 10t/ha CR + 100Kg/ha NPKF, 4t/ha SDA + 10t/ha CR + 200kg/ha NPKF, and 4t/ha SDA + 10t/ha CR + 300kg/ha NPKF increased mean root weight for the two sites by 54, 31, 19, 127 and 200% respectively.

Studies by Ojeniyi and Ighomrore (2004), Akanbi and Ojeniyi (2007), Awodun and Ojeniyi (1998), Ayeni et al (2008), Ojeniyi et al (2012) have shown that plant residual such as wood ash and chromolaena residues were effective as nutrient sources for crops such as amaranthus, maize, yam and cassava. The residues were effective in increasing yield of these crops and nutrients availability. Cocoa pod ash was also found to increase micro-nutrients such as Cu, Zn and Mn in soil (Ayeni et al, 2008) and micro-nutrients in plant (Ajayi et al, 2007, 2008). Therefore the residues ensured balanced nutrition and gradual release of nutrients to cassava, while NPKF ensured quick release of nutrients especially N which is essential for crop growth. The materials had complimentary role thereby enhancing cassava performance than when used alone.

This work found that combination of 4t/haSDA + 10t/ha CR + 300 kg/ha NPKF increased tuber yield of cassava by 200%. The residues reduced need for NPK fertilizer to 75% in addition to spectacular yield increase.

Table 1: Soil Nutrients as influenced by Plant residues and NPK Fertilizer at Ajegunle

	P		**K**		**Ca**		**Mg**
Treatment	**pH**	**OM%**	**N%**	**Mg/kg**		**cmol/kg**	
Control	5.2a	4.5b	0.22d	3.9e	0.33b	5.0d	2.1c
4t/ha SDA + 10t/ha CR	5.5a	6.8a	0.30b	5.6d	0.30c	5.8c	2.5b
400 Kg/ha NPKF	4.2b	4.9b	0.25c	4.8d	0.30c	5.7c	2.4ab
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	5.1a	6.3a	0.30b	7.0c	0.30c	6.1b	2.6a
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	5.0a	6.3a	0.30b	8.2b	0.35b	6.2b	2.6a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	4.8b	5.8a	0.40a	10.1a	0.42a	7.0a	2.9a

Table 2 – Soil Nutrients as influenced by Plant residues and NPK Fertilizer at Oka

	P		**K**		**Ca**		**Mg**
Treatment	**pH**	**OM%**	**N%**	**Mg/kg**		**cmol/kg**	
Control	6.3a	2.5c	0.10b	4.0e	0.20d	3.7e	1.4d
4t/ha SDA + 10t/ha CR	6.5a	4.6a	0.20a	6.4d	0.20d	5.3d	2.2b
400 Kg/ha NPKF	5.3c	3.1b	0.20a	5.7d	0.20d	5.0d	1.9c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	6.1a	4.3a	0.20a	8.6a	0.28c	5.8c	2.3b
4t/ha SDA + 10t/ha CR + 200 kg/ha NPKF	5.8b	4.0a	0.20a	12.4b	0.30b	6.3b	2.7a
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	5.6b	3.4b	0.23a	20.8a	0.40a	7.2a	3.1a

Table 3: Plant height of Cassava (cm) as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	122.3d	128.3f	157.0	168.0e	224.3e	189.0d	263.3d	282.3e
4t/ha SDA + 10t/ha CR	139.6c	145.3e	181.3	174.7d	242.3	247.6e	295.0c	313.0c
400 kg/ha NPKF	164.7a	194.0a	187.7	189.3c	251.3c	251.7d	291.0c	394.7d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	143.3c	152.8d	194.7	204.7b	261.3b	262.9b	301.0b	325.3b
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	149.0b	176.7c	199.3	209.3b	267.0b	265.2b	316.6a	333.7b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	159.3a	182.3b	218.3	230.7a	283.3a	304.7a	341.4a	370.0a

AY = Ayegunle
OK = Oke-Oka

Table 4: Number of Cassava leaves (per plant) as influenced by Sawdust ash (SDA) and Chromolaena residues (CR) at different months after planting (MAP) – Experiment 2

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	50d	52e	49e	67c	50a	32c	44d	74e
4t/ha SDA + 10t/ha CR	66c	63d	60d	82d	66d	68e	68c	161c
400 kg/ha NPKF	104a	114a	69c	90d	73c	76d	61c	127d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	70c	81c	79b	110c	81b	89c	93b	181c
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	74c	83c	83b	128b	97a	110b	100b	228b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	97b	95b	91a	156a	110a	143a	137a	243a

AY = Ayegunle
OK = Oke-Oka

Table 5 – Stem girth of Cassava (cm) as influenced by plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	5.6d	6.2c	6.9d	6.7c	6.6c	6.8c	6.7d	8.0d
4t/ha SDA + 10t/ha CR	5.7d	7.1b	6.2d	7.0bc	6.9c	9.0a	7.4cb	10.1c
400 kg/ha NPKF	7.9a	8.3a	6.7c	7.2bc	6.8c	8.4ab	7.3cb	9.2c
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	6.1c	7.4b	7.2b	7.6b	7.3b	9.6a	7.6a	10.5b
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	6.4b	7.8a	7.3b	7.7b	7.6b	8.7b	7.6a	10.7
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	6.9b	8.0a	7.9a	8.3a	8.6a	9.3a	8.5a	11.6a

AY = Ayegunle
OK = Oke-Oka

Table 6 – Leaf area index of Cassava as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	0.62d	0.6d	0.67d	0.83d	0.27d	0.17e	0.30f	0.8c
4t/ha SDA + 10t/ha CR	0.80c	0.7c	0.86c	1.13c	0.30c	0.22d	0.73d	1.8d
400 kg/ha NPKF	1.30a	1.4a	0.87c	1.20c	0.33c	0.40c	0.57e	1.5d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	0.90b	0.9b	0.97b	1.20c	0.40b	0.5b	0.87c	2.1c
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	1.1ab	1.0ab	0.93b	1.70b	0.40b	0.53b	1.10b	2.4b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	1.40ab	1.2ab	1.20a	2.10a	0.53a	0.70a	1.40a	2.8a

AY = Ayegunle
OK = Oke-Oka

Table 7: Fresh shoot weight (kg) of Cassava as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	6.7f	6.0f	5.0e	9.0d	6.0d	7.7f	9.0e	17.0e
4t/ha SDA + 10t/ha CR	7.7e	6.7e	6.7d	11.0e	10.0b	10.0d	18.3c	23.7c
400 kg/ha NPKF	12.3a	12.7a	7.3d	11.7c	7.3c	9.7e	13.0d	20.3d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	8.7d	7.7d	10.3c	14.3b	11.0b	12.3c	21.3c	28.0b
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	10.7c	9.0c	14.0b	15.7b	11.7b	14.0b	27.0b	29.b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	10.3b	11.7b	16.7a	19.3a	12.7a	15.3a	48.0a	50.7a

AY= Ayegunle
OK = Oke-Oka

Table 8: Fresh root weight (t/ha) of Cassava as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	5.7e	6.0d	5.3e	9.3f	10.0e	12.7e	13.3e	39.3e
4t/ha SDA + 10t/ha CR	8.7d	7.7c	7.0d	11.0e	13.7d	19.3c	23.0d	56.7d
400 kg/ha NPKF	16.3a	13.0a	9.3c	13.3d	13.0d	15.3d	17.0e	50.3d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	9.7c	8.0c	12.0b	15.7c	16.3c	20.0c	30.3c	62.3c
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	10.7c	9.0b	12.3b	18.0b	21.3b	24.3b	48.3b	69.3b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	13.0b	10.0a	15.0a	20.7a	36.3a	35.7a	67.7a	87.0a

AY = Ayegunle
OK = Oke-Oka

Table 9: Root diameter of Cassava (cm) as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	3.2c	2.7c	3.2e	3.2e	4.4c	5.1e	3.8f	7.7e
4t/ha SDA + 10t/ha CR	3.4c	2.8e	3.5d	3.9b	4.7b	5.6d	7.1d	8.4c
400 kg/ha NPKF	4.2a	3.8a	3.7c	3.9b	4.8c	5.1e	6.0e	7.5d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	3.9b	3.0d	4.1c	4.5a	6.5a	6.0c	7.9c	8.5b
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	3.8b	3.3c	4.5b	4.7a	6.9a	6.6b	8.6b	8.9b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	3.9b	3.5b	5.5a	5.0a	7.7a	7.7a	9.9a	9.8a

AY = Ayegunle
OK = Oke-Oka

Table 10 – Root length of Cassava (cm) as influenced by Plant residues and NPK Fertilizer

Treatment	3 MAP		6 MAP		9 MAP		12 MAP	
	AY	OK	AY	OK	AY	OK	AY	OK
Control	26.0c	30.4d	28.7d	31.3c	26.4f	30.9e	21.4e	41.7e
4t/ha SDA + 10t/ha CR	30.9b	33.3d	32.7c	36.1c	36.4e	37.4c	30.9d	47.3d
400 kg/ha NPKF	46.2a	47.4a	36.0c	36.1a	31.7e	32.9d	28.2d	44.2d
2t/ha SDA + 10t/ha CR + 100kg/ha NPKF	33.1b	34.7c	37.7c	42.0b	41.9c	39.0c	32.8c	51.1c
4t/ha SDA + 10t/ha CR + 200kg/ha NPKF	34.8b	39.0c	42.3b	45.1b	44.4b	43.2b	36.7b	51.5b
4t/ha SDA + 10t/ha CR + 300kg/ha NPKF	42.2a	41.2b	50.4a	50.2a	50.5a	53.2a	39.7a	56.7a

AY = Ayegunle
OK = Oke-Oka

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