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Effect of Sawdust Ash on Nutrient Status, Growth and Yield of Cowpea (*Vigna unguiculata* L. Walp)

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Abstract: The study investigated suitability of sawdust ash as nutrient source for cowpea. Six rates of ash: 0, 2, 4, 6, 8 and 10 t ha^{-1} were applied in two trials and soil and leaf nutrient composition and growth parameters were determined. Sawdust ash treatments applied to soil significantly increased soil and leaf N, P, K, Ca and Mg contents and numbers of pods, pod weight, number of branches, number of leaves and grain yield. Soil nutrient contents increased with the amount of sawdust ash up to 8 t ha^{-1} before it declined.

Key words: Cowpea, pod weight, number of leaves, grain yield and nutrient content, leaf nutrient, number of pods, pod weight

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) walp.) is the most important pulse crop in the savanna regions of West and Central Africa, where it is also an important vegetable a valuable source of fodder (Brink *et al*., 2006). Soils in areas of Southern Nigeria are acidic due to the nature of the parent material, heavy leaching and weathering. In addition to acidity, the soils suffer from nutrient deficiency (Owolabi *et al*., 2003). Although, cowpea derives a significant amount of the nitrogen requirements from the atmosphere and may leave 75-150 kg ha^{-1} in the soils for the benefit of succeeding crop (Brink *et al*., 2006). However, cowpea requires phosphorus for nodulation and root growth. Incorporation of 25 kg ha^{-1} is required for phosphorus and potassium deficient soils. Lime and chemical fertilizers are scarce and when seen are not affordable because of the high cost. Therefore, there is that need to investigate into the use of available domestic and agricultural waste that could serve as lime and fertilizer (Obi and Ekperigin, 2001).

Pod ash is known to contain an appreciable phosphorus and potassium (Odedina *et al*., 2003). Ojeniyi *et al*. (2001) found that yield of vegetable crops and nutrient content were improved by wood ash manure in trials conducted in Southwest Nigeria. Also, ash derived from burnt vegetation is known to reduce soil acidity, increase availability of cationic nutrients and improve yield of millet in Zambia (Araki, 1993).

The experiments being reported were conducted to study effect of wood ash manure treatments on nutrient status, growth and yield of cowpea.

MATERIALS AND METHODS

Field Experiment

Field experiment was conducted at Akure (7°16N, 5°15E) in the rainforest zone of Southwest Nigeria on a loamy sand soil, skeletal, Kaolinitic palenstalf (USDA soil taxonomy).

Two trials were conducted on manually cleared land using early maturing IT 84/716 cowpea variety obtained from International Institute of Tropical Agriculture, Ibadan, Nigeria between August and November, 2001 and 2002. Six levels of sawdust ash namely: 0, 2, 4, 6, 8 and 10 t ha^{-1} were replicated three lines on single plants spaced at 60×30 cm, each of the 18 plots being treatments were 25 m^2. At 2 weeks after planting, sawdust ash was applied by ring method. Manual weeding was done 3 times and novacron was sprayed against insects 6 weeks after planting.

Ten plants were selected on each of the 18 plots for data collection in each trial. At 9 weeks after ash application, plant height, number of branches and leaves were determined. Matured pods were harvested between 7 to 9 weeks after ash manure application, and the number of pods, pod weight, weight of 100 grains and grain yield per hectare basis were evaluated.

Soil Analysis

Surface (0-15 cm) soil samples collected on plot basis by anger in October were bulked, air-dried and 2 mm sieved for chemical analysis. The pH is 1.2 soil-$CaCl_2$ medium, total N by micro-kjeldahl method, available P by molybdenum blue colorimetry after Bray-1 extraction were determined. The exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined on flame photometer, and Ca and Mg by atomic absorption spectrometry (Tel and Hagarty, 1984).

Analysis of Sawdust Ash

Two grammes of sawdust ash were used for analysis. The N was determined by kjeldahl method, while determination of other nutrients (available P, exchangeable K, Ca, Mg, Na, Fe, Mn, Cu and Zn) was done using the wet digestion method based on 25-5-5 nitric-sulphuric and perchloric acids, respectively (Carter, 1993). The K, Ca, Na were read on flame photometer, while the Mg and micronutrients were read on atomic absorption spectrophotometer. The P content was developed into colouration with vanaclo-molybdenum solution and read on spectronic 20 at 442 Um (Moyin-Jesu, 2003).

Leaf Analysis

Cowpea leaf samples collected at 50% flowering were air-dried, ground and ashed at 450°C for 6 h in muffle furnace. The nutrients in the ash was extracted with water. The N was determined by micro-kjeldahl method and P by vanado-molybdate colorimetry. The K and Ca were read on flamephotometer using appropriate element filters, while Mg was determined on atomic adsorption spectrophotometer.

Statistical Analysis

Cowpea growth, yield data, soil analysis and leaf analysis data collected on sawdust ash treatment and replicate basis were subjected to analysis of variance and their means compared using least significant difference at 5% level of probability.

RESULTS AND DISCUSSION

Table 1 shows value of chemical analysis of sawdust ash. The surface (0-15 cm) soil had 74.6% sand, 13.4% silt, 12% clay, pH ($CaCl_2$) of 5.5, Organic Matter (OM) 1.3%, total N 0.06%, available P 6.2 mg kg^{-1}, exchangeable K 1.4 cmol kg^{-1}, Ca 0.81 cmol kg^{-1} and Mg 3.1 cmol kg^{-1} (Table 2). The values of pH, exchangeable K, Ca and Mg are suitable but the OM and available p-values were inadequate (Kparmwang *et al*., 2004).

The mean soil pH ($CaCl_2$) recorded for 0, 2, 4, 6, 8 and 10 t ha^{-1} ash treatments for experiment 1 and 2 are 5.5, 6.6, 6.6, 7.0, 7.2 and 7.2, respectively (Table 3 and 4). Therefore soil alkalinity increased with the amount of sawdust ash, indicating increasing supply of cations (K, Ca and Mg). The high soil pH of between 5.5 to 7.0 are suitable for crops in soils of Southwest Nigeria (Obi and Ekperigin, 2000).

Table 1: Chemical analysis of sawdust ash

Parameters	Conc. (g kg^{-1})
Total N	2.52
Available P	12.80
Exchangeable K	0.89
Exchangeable Ca	8.64
Exchangeable Mg	0.92
Exchangeable Na	0.67
Exchangeable Fe	0.26
Exchangeable Mn	0.73
Exchangeable Zn	0.08
Exchangeable Cu	0.06

Table 2: Pre-planting soil analysis for the experiments

Soil property	Values
Sand (%)	74.60
Silt (%)	13.40
Clay (%)	12.00
pH $CaCl_2$	5.50
Organic matter (%)	1.29
Available P (mg kg^{-1})	6.20
Exchangeable K	1.38
Mg (cmol kg^{-1})	0.81
Ca (cmol kg^{-1})	3.12

Table 3: Effect of sawdust ash manure on soil composition (2001)

Sawdust ash (t ha^{-1})	pH $CaCl_2$	Organic matter (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K	Ca	Mg
						----- (cmol kg^{-1}) -----	
0	5.4	1.16	0.08	5.4	0.9	2.5	0.5
2	6.2	1.99	0.14	11.9	2.3	5.8	1.1
4	6.6	2.09	0.14	17.1	2.9	8.1	1.6
6	6.9	2.24	0.17	21.2	3.9	8.8	2.0
8	7.3	2.41	0.18	29.8	5.0	9.7	2.9
10	7.4	2.38	0.17	28.3	6.3	11.1	3.3
LSD (0.05)	0.2	0.13	NS	4.1	0.7	2.6	0.4

NS: Not Significant

Table 4: Effect of sawdust ash on soil composition (2002)

Sawdust ash (t ha^{-1})	pH $CaCl_2$	Organic matter (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K	Ca	Mg
						----- (cmol kg^{-1}) -----	
0	5.7	2.36	0.21	22.5	3.1	5.7	1.1
2	6.8	2.40	0.24	35.4	10.7	18.6	2.5
4	6.7	2.91	0.30	40.8	12.5	25.9	3.3
6	7.1	2.88	0.35	60.6	13.5	25.6	3.3
8	7.2	2.93	0.35	76.4	19.3	32.3	3.8
10	7.1	3.26	0.35	66.2	23.6	24.7	3.9
LSD (0.05)	0.2	0.21	NS	0.8	2.3	5.6	0.4

NS: Not Significant

Ash treatments increased leaf N, P, K, Ca and Mg contents. Among the ash treatments (0, 2, 4, 6, 8 and 10 t ha^{-1}), the 8 t ha^{-1} ash gave higher leaf N, P, K, Ca and Mg contents at the two experiments under consideration (Table 5). The values dropped at 10 t ha^{-1} ash relative 8 t ha^{-1} ash. This could be due to very high soil pH (>7.0) recorded for 10 t ha^{-1} ash. The high pH could have adversely affected uptake of some nutrients micronutrients such as B, Cu, Fe (Obi and Ekperigin, 2001) and reduce root growth. Also, excessive Ca in soil due to 10 t ha^{-1} ash might have led to fixation and reduced availability of P. Cowpea grain yield and growth depends on the availability of P (Brink *et al*., 2006).

The effect of ash treatments on the plant height and number of branches were significant (p>0.05) as the 2, 4 and 6 t ha^{-1} ash significantly increased plant height and number of branches

Table 5: Effect of sawdust ash on leaf nutrient content of cowpea

Sawdust ash (t ha^{-1})	N (%) 2001	N (%) 2002	P (%) 2001	P (%) 2002	K (%) 2001	K (%) 2002	Ca (%) 2001	Ca (%) 2002	Mg (%) 2001	Mg (%) 2002
0	3.2	3.3	0.23	0.27	1.8	nd	0.40	0.57	0.11	0.16
2	5.1	5.3	0.32	0.60	3.3	nd	0.69	0.90	0.19	0.31
4	4.9	5.3	0.43	0.77	4.6	nd	1.93	1.00	0.45	0.54
6	5.7	5.6	0.64	0.56	5.0	nd	1.00	1.10	0.51	0.60
8	6.3	5.9	0.84	0.95	7.4	nd	1.30	1.40	1.85	0.92
10	5.6	5.3	0.58	0.60	6.8	nd	1.00	1.20	0.73	0.78
LSD (0.05)	0.9	0.7	0.18	0.23	0.8	nd	0.40	0.30	0.19	0.21

nd: Not detected

Table 6: Effect of sawdust ash manure on growth parameters of cowpea nine weeks after application

Sawdust ash (t ha^{-1})	Height (cm) 2001	Height (cm) 2002	No. of branches (mean) per plant 2001	No. of branches (mean) per plant 2002	No. of leaves per plant 2001	No. of leaves per plant 2002
0	29.5	36.4	12	12	32	33
2	36.8	40.2	13	13	37	39
4	41.5	43.6	18	17	43	44
6	43.6	48.7	24	24	49	52
8	48.5	60.3	31	30	59	61
10	48.7	59.0	26	28	52	54
LSD (0.05)	2.3	3.6	2	3	NS	5

NS: Not Significant

Table 7: Effect of sawdust ash manure on yield components of cowpea

Sawdust ash (t ha^{-1})	No. of pods per plant 2001	No. of pods per plant 2002	Pod weight per plant 2001	Pod weight per plant 2002	Weight of 100 grains (g) 2001	Weight of 100 grains (g) 2002	Grain yield (t ha^{-1}) 2001	Grain yield (t ha^{-1}) 2002
0	7	7	31.8	34.6	23.3	22.4	1.01	1.05
2	8	8	31.9	33.2	24.2	24.4	0.87	1.02
4	9	10	39.1	43.0	28.6	29.2	1.24	1.35
6	10	12	43.7	48.6	32.1	38.0	1.66	1.75
8	14	16	50.6	57.0	38.0	40.9	2.09	2.79
10	14	14	47.6	51.1	30.2	37.4	1.86	1.90
LSD (0.05)	2.3	2.7	10.2	11.9	3.9	4.4	0.18	0.36

(Table 6). Also, there were increases in the number of leaves with the increasing rates of ash treatment application. It is ascertained that increased uptake of N, P, K, Ca and Mg due to application of sawdust ash to soil led to increased growth of cowpea.

All sawdust ash (2, 4, 6, 8 and 10 t ha^{-1}) treatments increased number of pods, pod weight and weight of 100 grains (Table 7). As in case of leaf N, P, Ca and Mg contents, the 8 t ha^{-1} gave the highest values of yield components of cowpea. The positive response of cowpea to sawdust ash is consistent with earlier findings (Obi and Ekperigin, 2001; Ojeniyi and Adejobi, 2002; Odedina *et al*., 2003).

Findings from this research show that sawdust ash increased growth, yield components and the grain yield of cowpea.

CONCLUSION

Sawdust ash could be utilized as source of nutrients especially P and K in cowpea production. Its use would enhance growth and yield. Sawdust ash through a lining material is also good source of organic matter, N, P, K, Ca and Mg. Cowpea pod and grain yield were significantly improved by sawdust ash application. The 8 t ha^{-1} treatment most enhanced cowpea nutrient and yield.

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