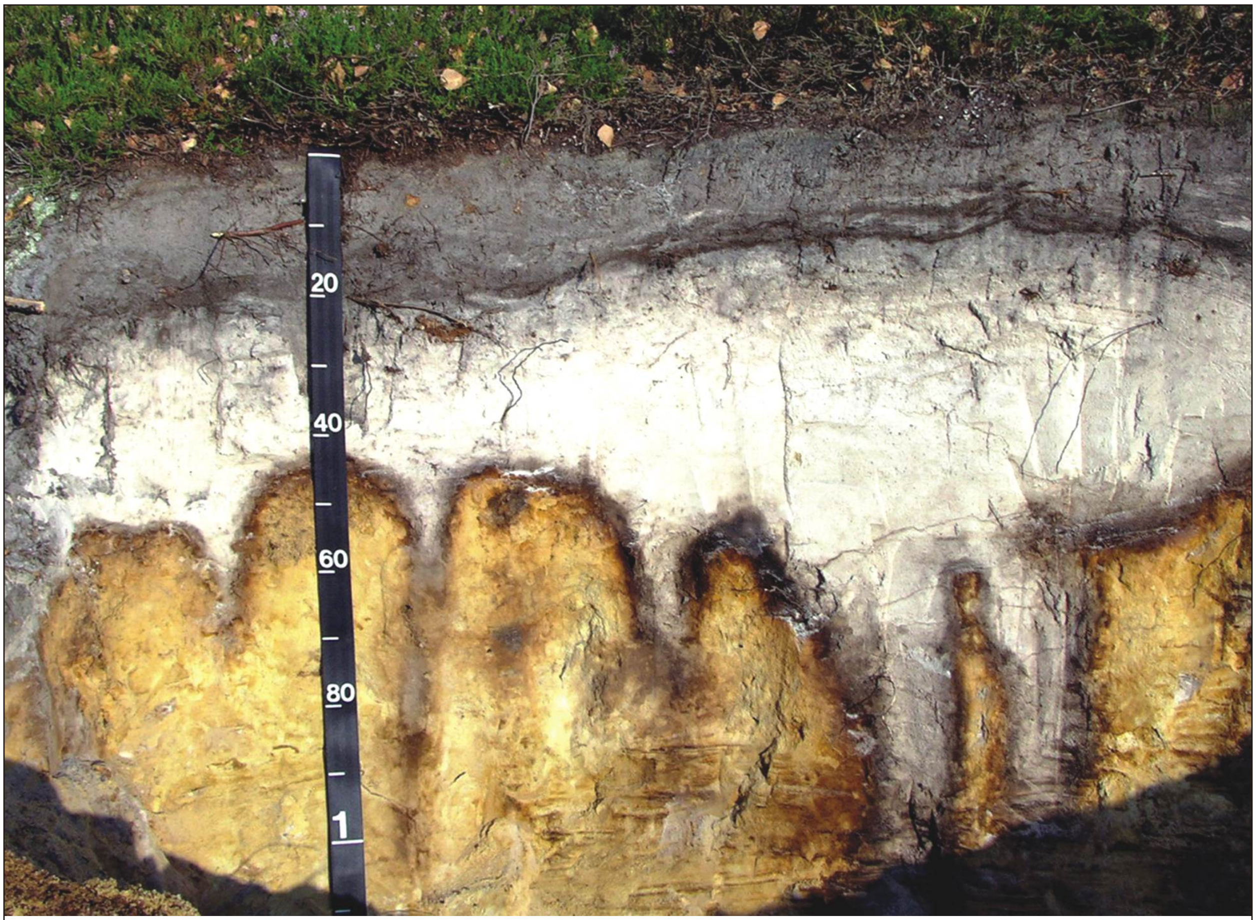

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Influence of Sawdust Ash on Soil Chemical Properties and Cowpea Performance in Southwest Nigeria

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Abstract: Field trials were carried out at two locations in fairly acidic soils in Southwest Nigeria to test effect of sawdust ash on soil chemical properties, leaf nutrient content and yield of cowpea (*Vigna unguiculata* Walps). Sawdust ash applied at 2, 4, 6, 8 and 10 t ha^{-1} significantly increased soil organic matter, pH, N, P, K, Ca and Mg contents relative to 0 t ha^{-1} sawdust ash. The 4, 6, 8 and 10 t ha^{-1} sawdust ash increased pod weight and grain yield. The mean increases in grain yield across locations were 17, 63 and 68%, respectively.

Key words: Sawdust ash, soil, cowpea, nutrients pod weight, grain yield

INTRODUCTION

Due to high cost and scarcity of chemical fertilizers, it has become necessary to source for agro-industrial wastes which could be used as manure for crops in tropical countries. In recent times that researchers were focused on the potential of these wastes as soil improvers and sources of nutrients. The wastes which have been proved as effective organic fertilizers include animal wastes, wood ash, rice husks, mill and brewery wastes, sawdust and other crop wastes.

Studies into use of sawdust ash which are left as wastes at sawmills, carpenter sheds and furniture factories as plant nutrient sources have not received attention. Odedina *et al*. (2003) found that sawdust ash at 2 to 8 t ha^{-1} increased yield of pepper (*Capsicum annum*) and tomato (*Lycopersicon esculentum*) significantly and also increased soil nutrients and plant N, P, K, Ca and Mg contents.

This work studied the effect of sawdust ash on soil and leaf nutrient contents, growth and yield components of cowpea in Southwest Nigeria.

MATERIALS AND METHODS

Field trials were conducted in Southwest Nigeria between August 2002 and 2003 at Akure and Ado-Ekiti respectively. Akure (7°16N, 5°15E) and Ado-Ekiti (7°31N, 7°49E) sites are in the rainforest zone. The Akure soil is Oxic Tropuldalt United State Depertment of Agriculture (USDA) while Ado-Ekiti soil is Sandy Arsenic Haphistalf. The sites were manually cleared. There were six sawdust as (0, 2, 4, 6, 8 and 10 t ha^{-1}) treatments applied to soil grown to cowpea 1T84/716 obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The treatments were replicated three times using a randomized complete block design. Each plot was 25 m^2 with cowpea spaced at 0.60×0.30 m at one plant per stand. Ash was applied in ring form after two weeks after planting. Manual weeding was done thrice.

Thirty plants were randomly selected on each plot for data collection. Air-dried pods were harvested between 7th to 9th weeks after planting and number and weight of pods taken. Grains were extracted and weighed and grain weights were converted to per hectare.

Soil Analysis

Pre-planting surface (0-15 cm) soil samples collected over each site were bulked for analysis. At completion of harvest 9 weeks after planting, samples were also collected from treatment plots. The samples were air-dried and 2 mm sieved. Particle size distribution by hydrometer method was done. The pH in soil-$CaCl_2$ (1:1) was determined using glass calomed electrode pH meter. Total N was evaluated by micro-kjeldahl approach. Organic Matter (OM) was determined by Walkey-Black Oxidation method and available P by Bray 1 extraction was evaluated by molybdenum blue calorimetery. Exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined using flame photometer and Ca and Mg by atomic absorption spectrometer Tel and Hagarty (1984).

Leaf and Sawdust Analysis

Cowpea leaf samples collected per plot at mid-flowering were air-dried, ground and ashed at 500°C for 2 h. Ash was dissolved in HCl to extract nutrients. Nitrogen was determined using Kjeldahl approach, P by molybdenum blue colorimetry, K by flame photometer and Ca Mg by atomic absorption spectrometer (Tel and Hagarty, 1984). Sawdust ash was also dissolved in HCl analyzed as for leaf.

Statistical Analysis

Cowpea growth, yield data, soil analysis and leaf analysis data collected in 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

Pre-planting soil analysis data are shown in Table 1. 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 soil chemical properties influenced by application of sawdust ash are shown in Table 2. Sawdust increased soil pH, OM, N, P, Ca and Mg. The values of these properties tended to increased with amount of ash. High positive correlations of 0.95, 0.95, 0.93, 0.95, 0.96, 0.91 and 0.98 were recorded for relationship between amount of ash and mean soil pH, OM, total N, P, K, Ca and Mg, respectively. Owolabi *et al*. (2003) and Odedina *et al*. (2003) had found that different types of ash enhanced soil pH and nutrient availability in soils of Southwest Nigeria. The increase in soil pH and cations associated with application of sawdust ash affirms that ash had liming effect. Other workers (Obi and Ekperigin, 2001) have successfully tried ash as a liming material.

Analysis of sawdust ash used in this work showed the values of 2.52 N, 12.8 P, 0.89 k, 8.64 Ca, 0.92 Mg, 0.67, 0.26, 0.73, 0.08 and 0.06 g kg^{-1}, respectively. The material is relatively high in P. The increase in soil nutrient contents as a result of application of sawdust ash implies that the component nutrients were mineralized to be made available in soil and subsequently for crop uptake.

Table 1: Pre-planting soil analysis for Akure and ado-ekiti, southwest Nigeria

Soil property	Akure	Ado-Ekiti
Sand (%)	74.60	88.00
Silt (%)	13.40	3.80
Clay (%)	12.00	8.20
pH ($CaCl_2$)	5.50	5.50
OM (%)	1.29	1.17
Available P (mg kg^{-1})	6.20	5.50
Exchangeable K (Cmol kg^{-1})	1.38	2.65
Mg (Cmol kg^{-1})	0.81	0.93
Ca (Cmol kg^{-1})	3.12	4.08

Table 2: Effect of sawdust ash on soil properties at akure and ado ekiti

Ash (t ha^{-1})	pH $CaCl_2$	OM	N	P	K	Ca	Mg
		----------(%)------------			------------------(mg kg^{-1})------------------		
Akure							
0	5.70	2.36	0.21	22.4	3.10	5.6	1.1
2	6.80	2.40	0.24	35.4	10.7	18.6	2.5
4	6.70	2.91	0.30	40.8	12.5	25.9	3.3
6	7.10	2.88	0.35	60.6	13.5	25.6	3.4
8	7.20	2.93	0.35	76.4	19.3	24.7	3.7
10	7.50	3.26	0.35	66.2	23.6	32.3	3.9
LSD (0.05)	0.18	0.21	NS	0.80	2.30	5.6	0.4
Ado ekiti							
0	5.40	1.16	0.08	5.40	1.00	2.5	0.5
2	6.20	1.99	0.14	11.9	2.30	5.8	1.1
4	6.60	2.09	0.14	17.1	2.90	8.1	1.6
6	6.90	2.24	0.17	21.2	3.90	8.8	2.0
8	7.30	2.41	0.18	29.8	5.00	9.7	2.9
10	7.40	2.38	0.17	28.3	6.30	11.1	3.3
LSD (0.05)	0.15	0.13	NS	4.10	0.70	1.3	0.4

Table 3: Effect of sawdust ash on leaf nutrient content of cowpea at Akure in 2002 (a) and 2003 (b)

	N %		P %		K %		Ca %		Mg %	
Ash (t ha^{-1})	A	B	A	B	A	B	A	B	A	B
0	3.2	3.3	0.23	0.27	0.6	1.8	0.40	0.47	0.11	0.16
2	5.1	5.3	0.32	0.60	1.2	3.3	0.64	0.90	0.19	0.31
4	4.9	5.3	0.43	0.77	1.8	4.6	0.91	1.05	0.45	0.54
6	5.7	5.6	0.64	0.56	1.6	5.0	1.00	1.06	0.51	0.60
8	6.3	5.9	0.84	0.95	2.2	7.4	1.29	1.37	1.85	0.92
10	5.6	5.3	0.58	0.60	2.1	6.8	1.00	1.15	0.73	0.78
LSD (0.05)	0.8	0.7	0.18	0.23	0.8	1.0	0.36	0.31	0.19	0.21

Table 3 shows data on leaf nutrient composition of cowpea in response to sawdust ash treatments. Ash treatments increased leaf N, P, K, Ca and Mg contents. Among the ash treatments (0, 2, 4, 6 and 8 t ha^{-1}), the 8 t ha^{-1} ash gave higher leaf N, P, K, Ca and Mg contents at the two sites under consideration. The values dropped at 10 t ha^{-1} ash relative to 8 t ha^{-1} ash. This could be due to very high soil pH (well exceeding 7.0) recorded for 10 t ha^{-1} ash. The high pH would have adversely affected uptake of some nutrients including micronutrients such as B, Cu, Fe (Obi and Akinsola, 1995) and reduce root growth. For cowpea, Obi and Ekperigin (2001) recommended liming to 5.5. Also, excessive Ca in soil due to 10 t ha^{-1} ash and might have led to fixation and reduced availability of P (Table 2). This should have adversely affected cowpea whose grain yield and growth depended on availability of P (Adetuyi, 1984). Generally, sawdust ash at 4 (t ha^{-1}) and above significantly ($p>0.05$) enhanced nutrient status of cowpea.

Table 4 shows data on yield components of cowpea. Sawdust ash treatments increased number and weight of pods relative to control (0 t ha^{-1}). The 4, 6, 8 and 10 t ha^{-1} ash increased pod weight and grain yield but 2 t ha^{-1} ash did not. As in case of leaf N, P, K, Ca and Mg contents, the 8 t ha^{-1} ash gave highest values of yield components of Cowpea. It is suggested that the availability of these nutrients dictated the performance of cowpea.

The yield parameters were significantly ($p>0.05$) increased by sawdust ash at 6, 8 and 10 t ha^{-1}. The increases in grain yield adduced to 4, 6, 8 and 10 t ha^{-1} ash at Akure were 23, 64, 107 and 84%, respectively. The values for Ado-Ekiti were 10, 60, 95 and 50%. Across the locations, they were 17, 63, 102 and 68%. In their trial on tomato, Odedina *et al*. (2003) also found that 8 t ha^{-1} sawdust ash most increased yield (77%).

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; Van Reuler and Janseen, 1996) that ash derived from plant sources served as liming material and increased nutrient uptake and yield of crops such as tomato, rice and vegetables.

Table 4: Effect of sawdust ash manure of yield components of cowpea plant

	Pods/plant (kg)		Pod weight/plant (gm^{-1})		Grain weight (t ha^{-1})	
Sawdustash	Akure	Ado	Akure	Ado	Akure	Ado
0	7.0	7.3	31.8	34.5	1.01	1.00
2	7.6	8.3	31.9	33.2	0.87	1.00
4	8.6	10.3	39.1	43.0	1.24	1.10
6	9.5	11.5	43.7	48.6	1.66	1.60
8	14.0	16.2	50.6	57.0	2.09	1.95
10	14.0	14.0	47.6	51.1	1.86	1.50
LSD (0.05)	3.3	2.7	10.3	11.9	0.36	0.20

Correlation coefficients between mean leaf N, P, K, Ca and Mg and cowpea pod weight were 0.76, 0.89, 0.95, 0.91 and 0.93, respectively. These values ascertain that increased availability of N, P, K, Ca and Mg enhanced cowpea yield. The correlations between sawdust level and leaf N, P, K, Ca and Mg contents of cowpea were 0.79, 0.76, 0.96, 0.86 and 0.76, respectively. These show that sawdust ash increased uptake of nutrients by cowpea. The correlations between sawdust ash level and number of pods and pod weight were 0.94 and 0.91, respectively. Hence, sawdust ash application and resultant increased availability of N, P, K, Ca and Mg positively influenced yield of cowpea.

CONCLUSIONS

Sawdust ash was an effective liming material and source of soil organic matter N, P, K, Ca and Mg. Its use as manure for cowpea significantly improved leaf N, P, K, Ca and Mg contents of cowpea, pod and grain yield on slightly acidic soils of Southwest Nigeria. The 8 t ha^{-1} treatment most enhanced cowpea nutrient content and yield.

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