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USE OF ASH FOR SOIL FERTILITY IMPROVEMENT EFFECT ON COWPEA

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ABSTRACT
Different rates of wood ash at 0 to 6t/ha were applied to cowpea crop in an experiment carried out at Akure, Southwest Nigeria to study effects of ash on cowpea performance soil and plant nutrients composition. The experimental soil is slightly acidic, low in available P and exchangeable Ca. Ash increased soil pH which increased with the rate of ash. Available P, exchangeable Ca, K and Mg were increased. Concentrations of N, P and Ca in plant increased between 0 to 6t/ha ash, and K and Mg increased between 0 to 6t/ha ash. Plant height, number of leaves, pod length, fresh and pod weight increased with rate of ash between 0 to 6t/ha.

INTRODUCTION

Application of wastes generated from domestic, agricultural and industrial activities on agricultural land is a means of their disposal although the organic wastes could increase presence of plant nutrients in soil. They could be explored as an alternative to costly chemical fertilizers in crop production. Moreover since commercial N fertilizers is not recommended for leguminous crops, it is advocated that organic manure should be applied along with rhizobium culture (Olayinka, 1990).

Unorthodox liming with organic materials such as wood ash is expected to be beneficial to plants grown in acidity soil. A major effect of soil acidity is reduction in ability of plants to fix N_2, either by interfering with nodulation or reducing availability of Mo. Acidic soil as found in Southern Nigeria causes ineffective nodulation because of its low Ca, Mg, P and Mo status (Soretire and Olayinka, 2013), Rhizobial cell has specific requirement for Ca for cellwall development. Ca ions also counteract soil acidity. Also, liming of acid soils in the tropics reduces AI and Mn toxicity and improves availability N and P. The most commonly used liming materials are oxides, carbonates and silicates of Ca and Mg. According to Soretire and Olayinka (2013), only scanty information is available on unorthodox materials such as shells, fine dust and wood ash as to their liming and phosphate fertilizer effectiveness. They are usually dumped in land fills. Ojeniyi (2012) and Abdulhamid and Mustapha (2009) indicated that ash has liming and fertilizing effect in crop production.

Some researchers in Nigeria reported that wood ash increased nutrients availability (Owolabi *et al.,* 2003; Ojeniyi *et al.,* 2002) and crop performance in production of crops such as Soybeans (Akinola *et al.*, 2013, Soretire and Olayinka, 2013a, 2013b), Sorghum (Abdulraheem and Ojeniyi, 2015), cassava (Babadele and Ojeniyi, 2013a, 2013b, Ojeniyi *et al.*, 2015),

tomato and pepper (Ewulo *et al.,* 2009, Odedina *et al.,* 2003), amaranthus (Ojeniyi and Adejobi, 2002), groundnut (Awodun and Ojeniyi, 2005, Obiefuna *et al.,* 2003) and vegetables (Ojeniyi *et al.,* 2002). This work was aimed at determining effects of wood ash on soil and plant nutrients composition, growth and yield of cowpea.

MATERIALS AND METHODS

Cowpea experiment

A Screen house experiment on Ife brown cowpea involving four ash treatment, 0, 2, 4, and 6t/ha applied to cowpea seedlings was conducted in perforated plastic pots. Pots containing 4 kg soil each were used. There were 3 pots per treatment, replicated three times, giving a total 36 potted seedlings. Test soil was collected from teaching and research farm, Federal University of Technology Akure, while ash were derived from burnt sawdust collected from Department of Wood Technology. Test Ife Brown cowpea seeds were planted at 3 seeds per pot. Thinning to one plant was done two weeks after planting followed by application of ash by ring method. Watering was done at 2 days interval.

Crops Data

Data on plant height, stem girth above soil level, and number of leaves were collected at 4, 5, 6 and 7 weeks after planting using appropriate equipment (WAP). Matured pods were harvested between 9 to 12 WAP and pod length, fresh pod weight, dry pod weight were determined.

Soil and plant analysis

At the last harvest (12WAP) Soil sample was collected per treatment and 2 mm sieved. Routine analysis was carried out for organic matter by wet dichromate method total N by Kjedahl method, available P by Bray - P1 extraction method followed by molybdenum blue colorimetry, and exchangeable K, Ca and Mg by ammonium acetate extraction, after which K was read on flame photometer and Ca and Mg determined by EDTA titration. The pH in soil $CaCl_2$ (1:2) was determined using pH meter.

Plant analysis

Cowpea plant samples were oven dried at 65^0C and ground. Ground samples were digested using concentrated sulphuric acids. Total N and P were determined as for soil, and K and Ca and Mg were read on atomic absorption spectrophoto meter.

RESULTS AND DISCUSSION

The pH ($CaCl_2$) for experimental soil was 6.3, Organic matter (OM) 3.9 %, total N 0.52 % available P 12.0 mg/kg exchangeable Ca 3.75 cmol/kg, Mg 0.90 cmol/kg and K 0.70 cmol/kg. The soil is slightly acidic, available P and exchangeable Ca not adequate for crop production. (Table1).

Data on chemical analysis of two wood ash samples sourced from Ojeniyi (2012) are shown in Table 2. Calcium had highest values, therefore, it is expected that ash has liming effect (Soretire and Olayinka, 2013a, 2013b). Ash also contained N, P, K and Mg. Hence it influenced positively soil nutrients content and performance of cowpea.

Table 3 shows that ash applied at 2 to 6 t/ha increased soil pH which tended to increase with rate of ash. Thus, ash had liming effect which is attributable to increase in Ca. Ash at 2 t/ha increased exchangeable K significantly. The K increased with rate of ash between 0 to 4 t/ha. Soil total N was increased with ash application under cowpea although relationship between ash rate and N was not linear. Increases in N up to 4 t/ha

ash is attributable to N fixation by cowpea (Table 3). Soil P increased with ash rate. Ash should have returned soluble nutrients to soil in form of P, K, Ca and Mg from OM.

Data on cowpea plant nutrients composition are show in Table 4. Values of N, P and Ca increased with the rate of ash between 0 to 4 t/ha, and for K and Mg values increased between 0 to 6 t/ha. However, it is shown that 6t/ha as h depressed plant N, P and Ca relative to control. The least values of these nutrients might be due to their immobilization in soil by microorganisms acting to break down OM and neutralized organic nutrients. It could be noted that SOM tended to reduce with increasing rate of ash between 0 to 4 t/ha ash.

Performance data of cowpea collected weekly between 4 to 7weeks after planting indicate that plant height (Table 5), number of leaves (table 6), pod length, fresh and dry pod weight (Table 7) generally increased with rate of ash between 0 to 6 t/ha. Number of leaves increased between 0 to 4 t/ha in the fourth, fifth and sixth week after planting. The 2 t/ha gave highest values of number of leaves, it also gave highest plant height at 6 and 7 WAP. Increase in pod weight due to 2, 4 and 6 t/ha ash were 62, 69 and 82% respectively. Hence the 6 t/ha ash is recommended.

Table 1: Pre experiment Soil Chemical Properties

pH $Cacl_2$	pH H_20	OM%	N%	P	Ca	Mg	K
6.3	6.9	3.9	0.53	12.0	3.35	0.90	0.70

Table 2: Analysis of wood ash

%	Value	
	Sample A	Sample B
N	0.28	1.72
P	0.14	0.16
K	0.81	0.97
Mg	0.41	0.90
Ca	1.92	9.72

Source: Ojeniyi (2012)

Table 3: Soil Properties as influenced by ash (Cowpea experiment)

Ash t/ha	pH	N %	P mg/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg	OM %
0	4.1d	0.07c	4.1d	22.1c	3.3b	4.9b	2.7b
2	5.5c	0.40a	6.1c	30.4b	9.2a	1.8c	1.5c
4	5.8b	0.30b	6.76c	43.8a	1.4d	9.8a	1.2c
6	5.9a	0.27b	7.2a	30.8b	2.6c	9.0a	3.3a

The significant effect of 2 t/ha ash on yield is consistent with the finding that it gave highest plant N, P and Ca concentrations. Hence, their nutrients dictated performance of cowpea. Starter close of N is recommended for cowpea although is a N-fixer. Unless the P nutrition of cowpea is improved, its full potential to N economy of soil may not be realized through N fixation. Biological N fixation has a high requirement for P. Liming and supply of Ca is necessary to control soil acidity where it exists because acidity is known to determine micronutrients uptake by cowpea and N fixation by rhizobium (Soretire and Olayinka, 2013b).

The highest pod yield was given by 6 t/ha ash which highest organic matter content of 3.3%, highest available P and less acidity of 5.9 and relatively high exchangeable K. This asserts that soil OM, P and less acidity are favourable to cowpea. The highest OM due to application of 6 t/ha ash could have been responsible to the soils highest available P and relatively high K, Mg and highest pH. These attributes should have influenced highest pod yield given by 6 t/ha ash. Olayinka *et al.* (1998) found that organic amendments could benefit rhizobium which are heterotrophs and N_2 fixation especially in soils low in organic matter. Adebayo (1985) cited by Olayinka (2013b) reported that cowpea rhizobium benefited from addition of small amount of manure. Soretire and Olayinka (2013) concluded in their study that combination of cow

Table 4: Cowpea Plant Nutrient Composition

Ash t/ha	N	P	K	Ca	Mg
0	6.03b	0.63b	21.5c	0.73ab	0.77bc
2	9.60a	0.87a	39.3a	0.87a	0.45c
4	8.87a	0.73ab	40.9a	0.8ba	1.03b
6	3.07c	0.61b	35.5b	0.61b	1.99a

Table 5: Effect of wood ash on height of cowpea

	Weeks after planting			
Ash t/ha	4	5	6	7
0	26.3b	32.1ab	50.5ab	54.2b
2	28.7a	36.5a	54.2ab	62.7a
4	25.3b	36.2ab	54.4a	65.9a
6	25.8b	29.9b	45.4b	54.9b

Table 6: Effect of wood ash on cowpea member of leaves

	Weeks after planting			
Ash t/ha	4	5	6	7
0	5.06b	6.56a	7.78b	10.33b
2	5.78a	6.78a	10.22a	16.33a
4	5.33ab	6.67a	9.67a	14.67a
6	4.89b	6.33a	7.56b	12.22b

Table 7: Yield of cowpea as influenced by ash

Ash t/ha	Pod length cm	Fresh Pod weight g	Dry Pod weight g
0	11.2b	3.54b	1.21bc
2	14.9a	4.59a	1.96b
4	14.6a	4.83a	2.04b
6	15.7a	5.15a	2.20a

dung and wood ash applications with rhizobial inoculation improved nodulation and N_2 fixation by soybean in acid soils.

CONCLUSION

This work shows that ash derived from sawdust is an effective source of macronutrients for enhanced productivity of cowpea, it recommended at 6 t/ha. Ash is also useful to rectify soil acidity which adversely affects performance of cowpea. It is a source of P and Ca which are essential for nodulation.

REFERENCES

Abdulraheem, M.I., Ojeniyi, S.O. and Charles, E.F. (2012). Integrated application of urea and sawdust ash effect on soil chemical properties plant nutrients and soghum performance. *IOSR Journal of Agriculture and Veterinary Science* 1(4), 38-41.

Abdulraheem, M.I. and Ojeniyi, S.O. (2015) Combined application of urea and sawdust ash in okra production effects on yield and nutrients availability. *Nigerian Journal of Soil Science* 25, 146-154.

Akinola, M.O., Ojeniyi, S.O. and Amusan, A.O. (2013). Soil chemical composition and soybean yield as influenced by tillage and ash. *Nigerian Journal of Soil Science* 22(1), 24-28.

Akinola, M.O. and Ojeniyi, S.O. (2014). Evaluation of soil chemical properties and yield of soybean in differently tilled soils (2008-2010). *Nigerian Journal of Soil and Tillage Research* 1, 9-15.

Awodun, M. A. and Ojeniyi, S.O. (2005). Response of groundnut yield and nutrient status to tillage and wood ash. *Nigerian Agricultural Journal* 36, 80-87.

Babadele, D.O. and Ojeniyi, S.O. (2013). Cassava yield as effects by sawdust ash and Siamweed residue and NPK fertilizer. *Nigerian Journal of Soil Science* 23(2), 282-290.

Babadele, D.O., Ojeniyi, S.O. and Agbede, O.O. (2013a). Periodic nutrient content of cassava as influenced by sawdust ash and siam weed residue. *Proceedings 37th Annual Conference of Soil Science Society of Nigeria*, Lafia. P 133-140.

Babadele, D.O., Ojeniyi, S.O. and Agbede, O.O. (2013b). Periodic evaluation of growth and root count of cassava and effect of sawdust ash and Siam weed residue. *Proceedings 37th Annual Conference of Soil Science Society of Nigeria*, Lafia. P 141-150.

Ewulo, B.S., Babadele, D.O. and Ojeniyi, S.O. (2009). Sawdust ash and effects on soil and plant nutrient contents and yield of tomato, *American Eurasian Journal of Sustainable Agriculture*3(1),88-92.

Nottidge, D.O., Ojeniyi S.O., Asawalam, D.O.

(2007). Effect of different levels of wood ash on nutrient contents of maize and grain yield in an acid ultisol of Southeast Nigeria. *Nigeria Journal of Soil Science* 17,98-103.

Obiefuna, J.C., Ibeawuchi, I., Ekong, E. A., Okoli, N.A. and Alagba, R. A. (2012). Liming efficiency of organic and inorganic limes for acid soil amelioration and production of groundnut in Tropical rainforest - ultisols of Southeastern Nigeria. *Proceedings of the 8th Annual Conference on Organic Agriculture University of Calabar* P 18-22.

Odedina, S. A., Odedina, J. N., Ayeni, S.O., Arowojolu, S. A., Adeyeye, S. D. and Ojeniyi, S.O. (2003). Effects of types of ash on soil fertility nutrient availability and yield of tomato and pepper. *Nigerian Journal of Soil Science* 13, 61-67.

Ojeniyi, S.O. and Adejobi, K.B. (2002). Effects of ash and goat manure on leaf nutrient composition growth and yield of amaranths. *The Nigeria Agricultural Journal* 33, 46-57.

Ojeniyi S.O., Oso, O. P. and Arotolu, A.A. (2002). Response of vegetables to wood ash fertilizer. *Proceedings of the 35th Annual Conference of Agricultural Society of Nigeria, UNAAB*, P 39-43.

Ojeniyi, S.O. (2012). *Tropical Soil Management and Agriculture in Nigeria*. 2nded. Bash Moses Publishers Ibadan PP122.

Ojeniyi, S.O. (2013). Wood ash as liming and fertilizing material in crop production. 9th National Conference on Organic Agriculture Abeokuta. 11-15th November 2013.

Odedina, S. A., Adeyeye, J.W., Ayeni, S.O., Arowojolu, S.A., Adeyeye, S. D. and Ojeniyi, S.O. (2003). Effects of types of ash on soil fertility nutrient availability and yield of tomato and pepper. *Nigerian Journal of Soil Science* 13,61-67.

Ojeniyi, S.O., Adejuwon, A. and Abdulraheem, M.I. (2015). Soil Physico-chemical properties and cassava yield in alfisol given tillage ash treatments. *Nigerian Journal of Soil Science (Special)* 25,71-82.

Olayinka, A., Adetunji, A. and Adebayo, A.A. (1998). Effect of organic amendments on nodulation and nitrogen fixation by Cowpea, *Journal of Plant Nutrition* 21(11), 2455 – 2464.

Owolabi, A.O., Adeyeye, A., Oladejo, B.T. and Ojeniyi, S.O. (2003). Effects of woodash on soil fertility and crop yield in Southwest Nigeria. *Nigerian Journal of Soil Science* 13, 55-60.

Soretire, A.A., and Olayinka A. (2013a). Response of soybean (*Glycine max*. L.) to cowdung and wood ash application in tropical acid soils of Southwestern Nigeria. *Nigeria Journal of Soil Science* 23(2), 103-113.

Soretire, A.A. and Olayinka, A. (2013b). Soybean nodulation and N2 fixation as influenced by cowdung wood ash and rhizobial inoculation in tropical acid soils (Typic Dystrudept). *Nigerian Journal of Soil Science* 23(2), 114-125.