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WASTE AS ALTERNATIVE LIMING MATERIALS IN ACID SOIL MANAGEMENT

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Abstract

This study was to appraise the comparative effectiveness of some industrial and domestic waste in managing soil acidity. The wastes investigated were: Fluedust, Silicate, Slag and Woodash. Calcium Carbonate was included for comparative purpose. The test crops were; Black-eyed bean, *Phaseolus vulgaris,*Ife brown cowpea, *Vigna unguiculata*and Soybean, *Glycine maxima*. These legumes were grown in the Greenhouse for 60 days. An assay of the waste showed that they were high in calcium, carbonate and phosphorus. The dry - matter yield of legumes were significantly improved when the soil was treated with any of the wastes. The highest dry-matter yield of legume (4.06 gram/pot) was obtained with black-eyed bean when the Soil pH was raised to 5.5. Plant uptake of Nitrogen, Phosphorus, Potassium and Calcium was significantly increased with the waste addition. Among the three legumes, uptake of calcium was highest in black - eyed bean and least in soybean. The waste used as liming materials in this study significantly increased the dry – matter yield of the indicator legumes. The order of effectiveness of the waste as liming materials followed this order: fluedust > wood ash > silicate slag. The wastes significantly improved the soil organic matter contents, thereby enhancing the soil health status.

Key words: *Acid soil, dry-matter yield, management, phytotoxicity, waste.*

INTRODUCTION

One of themajor problems encountered by farmers in South Western Nigeria is low crop yield occasioned by inherent Soil acidity. Most of the soils are generally classified as Oxisols and Ultisols, the fertility of which is limited by high Fe and Al contents, low activity clay and low organic matter content. These soils do not produce optimally when cultivated since available nutrients are low.

In Order to improve the food production capacity of the small-scale farmers, the need to properly manage the acid soil becomes important. Of the management options available, Person (1975) noted that the use of Lime has no close substitute. Addition of Lime reduces soil acidity and through this Neilson *et al*., (1991) explained that Liming enables plant roots to probe further and reach deeper into soils for nutrients. This they (Neilson *et al*., 1991) noted will alleviate the problems of Low Soil pHand Phytotoxicity associated with acid soils. Walsh (1970), grouped wastes and byproducts, either industrial or domestic as unorthodox liming materials. Yagodin, (1984) later reported that wastes containing Ca and Mg compounds without substances that are harmful to plants could be effective liming materials. With the removal of fertilizer subsidies by the government of Nigeria, the commercial liming materials become unaffordable by the resource poor small scale farmers. Hence wastes, either as industrial or domestic by-products become obvious alternative if the capacities of the small-scale farmers to produce more food are to be enhanced.

Hence, the Objective of this investigation is to evaluate the potentials of some wastes (Fluedust), Silicate Slag, and Woodash) as liming agents for acid soils through their influence on crop yield and nutrient availability.

MATERIALS AND METHOD

This investigation was conducted on a soil collected from a site that had been under continuous cultivation for two decades at the Teaching and Research Farm of the Obafemi Awolowo University Ile -lfe, Nigeria (7^0 28^0 N, 4^0 37E).The site is located on an Iwo Soil Series — Oxic Tropodalfs (Ojanuga, 1975) in the rain forest zone of South Western Nigeria. The Soil is well drained sandy loam in texture and derived from granitic rock and gneiss. Both the physical and chemical properties of the Soil were determined and are as described by Obi and Ekperigin (2000).

The materials used as liming agents were; Silicate Slag, Fluedust, woodash and Calcium Carbonate. Calcium carbonate was included for comparative purpose. Silicate Slag is a by-product from Delta Steel Company, Aladja near Warri in Delta State of Nigeria. While, the Fluedust is a byproduct of the cement factory in Ewekoro near Abeokuta in Ogun State of Nigeria. Woodash is a remnant from where firewood was being used for cooking at the kiosks in Obafemi Awolowo University campus Ile - Ife. These materials were sieved with 60mm Sieve to ensure uniform degree of fineness.

The study was conducted in the Greenhouse to determine the Soil pH at which the liming materials are most effective in improving nutrient uptake and crop yields. Average Soil pH (0.01 M $CaCl_2$) was 3.8 at the beginning of the Study. Two Kg of the Sieved air dried soil samples were weighed into four litre capacity plastic pots. Varying weights of each of the

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Liming materials wereadded to and thoroughly mixed with Soil Samples to bring the soil pH to 4.5, 5.5 and 6.5 units. The test crops were three legume species. Black-eyed bean *Phaseolus vulgaries,* Ife browns Cowpea *Vigna unginculata* and Soyabean *Glycine maxima*. Seeds of the legumes were placed 1.5 cmbelow the soil surface in the pots and covered with soil to a depth of 2cm. Each pot carried four stands of a given Legume and the crops were grown for 60 days at 23 –28 .00 and 13-11 hours day/night cycle. A control treatment was included. The experimental design was 4 x 4x3 factorial i.e four types of liming materials, four rates of addition and three types of Legume all replicated four times. Water loss through evapotranspiration was estimated byweighing and replaced with deionized water. After 60 days of growth, the above - ground portion of each of the crops was harvested and dried under forced air draft oven at 70^0**C.**The dry matter yield of the plant tissue was determined by oven dried plant samples were ground and analyzed for nutrient uptake. At the completion of the greenhouse work, the soil in each pot was sampled and assessed for changes in some chemical properties.

The differences for the collected data was determined using Analysis of variance (ANOVA) while a protected Duncan’s Multiple Range Test was used to determine significant differences in the main effect means. For these, SAS Software package was used (SAS institute lnc.1987).

RESULTS

Treatment effect on dry - matter yield of legumes.

The wastes and calcium Carbonate used as Liming materials in this study were increasing primary production of all the indicator legumes. There was a significant increase in the dry matter yield of the Legumes at all levels of lime/waste addition irrespective of the type of Liming material used (Tables la and b). As the Soil pH increased through liming, there was an incremental dry — matter yield of the three legume species used (Table 1 a). The highest dry matter yield of 4.06gpot was obtained at a Soil pH of 5.5. Liming beyond this point to pH 6.5 resulted in Significant decline in dry-matter yield of two of the three legumes. Decline recorded for Soybean was however not significant. There was a significant difference in the dry - matter yield among the crop species" Black-eyed bean produced the highest dry - matter of all the Legumes irrespective of the Liming materials added (Table lb). The mean dry-matter yield of Ife brown Cowpea (1.6lg/pot) was 56% that of the Black-eyed bean (2.88g/pot).

The type of liming materials used significantly affected the dry matter yield of crops though with no consistent trend of Ife Brown Cowpea in wood-ash treated Soil (1.74g/pot) was significantly higher than those from the other liming materials. With the Soil that received separate treatment of fluedust and calcium - carbonates were significantly better than either woodash or Silicate Slag treated soil. As for soyabean, soil treated with Fluedust produced dry - matter yield significantly better than the yield of the same crops treated with any the other three liming materials comparing absolute values, the Soil treated with Fluedust and cropped to Black-eyed bean produced the highest dry-matter yield of 3.14g/pot which was Slightly higher than the dry-matter yield of same crop in Calcium - carbonate treated Soil.

Table 1a: Effect of soil pH levels (0.01M $Cacl_z$) on dry - matter yield (g/pot) of legumes.

Soil pH Levels	Ife Brown Cowpea	Black-eyed Bean	Soybean	Mean
3.8	0.97 ± 0.31	1.70 ±0.63	1.01 ±0.29	1.23
4.5	1.48 ±0.48	2.23 ±0.54	1.15 ±0.34	1.62
5.5	2.07 ±0.74	4.06 ±0.5	1.83 ±1.03	2.66
6.5	1.89 ±0.71	3.53 ±0.80	1.80±0.71	2.41
Mean	1.61	2.88	1.48	1.99

Table lb: Effect of the Liming materials on dry — matter yield (g/pot) of Legumes. Liming materials Ife brown Cowpea

LIMING MATERIALS	Ife Brown Cowpea	Blackeyed Bean	Soybean	Means
SILICATE SLAG	1.47 ± 0.64	2.55 ± 1.01	1.37 ± 0.86	1.80
FLUEDUST	1.58 ± 0.93	3.14 ± 1.42	1.78 ± 1.07	2.13
WOODASH	1.74 ±0.68	2.81 ± 0.84	4.19 ± 0.33	1.92
CALCIUM CARBONATE	1.64 ± 0.60	3.11 ± 1.41	1.44 ± 0.40	2.07
MEAN	1.61	2.90	1.45	2.41

*Standard errors of the means are in parenthesis

Treatment Effects on nutrient uptake of Legumes.

Major Elements; N, P K, Ca and Mg.

Uptake of nitrogen (N) by legumes was Significantly influenced by the addition of liming materials irrespective of the sources. Rate of application of the liming materials significantly affected the uptake of N by the Legumes but not beyond the rate that brought the Soil pH to 5.5 units (Tables 2a, b, and c). The amount of N taken up by Ife brown Cowpea and black-eyed bean was slightly over 100% increment at pH 5.5 compared to the control plots. This is irrespective of the type of liming materials added. Though it may amount to economic waste to apply beyond pH 5.5, there was no significant difference in the %N uptake for Soils Limed to pH 5.5 and 6.5. This is true for all crops used except with Ife brown Cowpea and Soybean where Fluedust and Silicate Slag were the sources of liming materials respectively.

Crop uptake of phosphorus (P) followed almost a similar pattern as that of N. Rate of liming materials added significantly affected uptake and utilization of P. The higher the rate of liming materials added the greater the P uptake.

The highest amount of P in all legumes irrespective of the type of liming materials used, was however at the rate which raised Soil pH to 5,5. P uptake at this rate was significantly higher and different from the rate, which brought pH to 6.5 for all liming materials. The highest amount of P uptake occurred for all legumes where woodash was the source of liming material added (Tables 2a, b and c).

Potassium uptake by the legumes was significantly affected by the addition of the liming materials and mostly at the rates that brought the Soil pH to 5.5 units and above.

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Table 2a: Effects of different Liming Materials on Nutrient Uptake of black-eyed bean.

Liming Materials	Rates (Mg/h)	Soil pH Levels	Ca $cmolkg^{-1}$	Mg $cmolkg^{-1}$	K $cmolkg^{-1}$	P $mgkg^{-1}$	N g/kg^{-1}
SILICATE	0.00	3.8	14.2 ±0.1	11.1 ±0.0	98.0. ±8.9	157.5 ±29.9	1.5 ±0.1
SLAG	1.12	4.5	23.8 ±0.2	12.3 ±0.1	105.5±13.1	290.0 ±48.8	2.3 ±0.4
	3.20	5.5	32.0 ±0.3	13,4 ±0.0	123.8±3.5	403.8±12.5	3.1 ±0.3
	8.96	6.5	33.1±0.1	13.5 ±0.1	130.5±1.5	317.5 ±30.9	3.0 ±0.2
FLUEDUST	0.00	3.8	14.4 ±0.1	10.9 ±0.1	87.3 ±7.5	162.0 ±9.8	1.5 ±0.1
	0.95	4.5	29.0 ±0.4	13.3 ±0.0	97.3 ±33.6	223.3 ±25.3	2.7 ±0.3
	2.24	5.5	38.2 ±0.2	13.6 ±0.0	133.0 ± 2.2	293.8 ±21.3	3.6 ±0.3
	6.20	6.5	39.3±0.2	13.7 ±0.1	136.3 (2.6	318.8±15.4	4.1 ±0.2
WOODASH	0.00	3.8	14.8±0.3	11.1 ±0.1	95.0 ±9.6	153.3±25.2	1.4±0.1
	1.06	4.5	30.8±0.5	14.8 ±0.0	101.3 ±25.0	380.0 ±21.6	2.5 ±0.6
	2.80	5.5	34.0±0.2	15.5 ±0.1	154.3 ±1.7	535.0 ±50.0	3.1 ±0.3
	7.50	6.5	34.3 ±0.2	15.0 ±0,1	152.3 ±3.1	358.8 ±19.3	3.0 ±0.1
CALCIUM	0.00	3.8	14.2±0.2	11.1±0.1	96.5 ±8.6	161.8 ±23.9	1.4 ±0.1
CARBONATE	0.78	4.5	35.3 ±0.6	13.3(0.1	100.5 ± 14.1	311.3 ±65.3	2.7 ±0.3
	2.00	5.5	39.1 ±0.2	44.4(0.2	123.3 ±1.0	395.0 ±54.4	3.3 ±0.5
	4.48	6.5	40.2±0.3	14.5(0.2	131.0 (1.2	312.5 ±25.0	3.8 ±0.3

*Values in Parenthesis are Standard error of the means

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Table 2b: Effect of Different Liming Materials on Nutrient Uptake by Ife Brown Cowpea.

Liming Materials	Rates (mg/h)	Soil pH Level	Ca	Mg cmol/Kg^{-1}	K Cmol/kg	Avai.l P mgkg^{-1}	N g/kg
SILICATE	0.00	3.8	18.2 ±0.2	11.2 ±0.1)	86.8 ±5.7	143.8 ±23.9	1.3 ± 0.3
SLAG	1.12	4.5	24.4 ±0.3	12.5 ±0.0)	119.3 ± 9.4	265.0 ±37.0	2.5 ±0.4
	3.20	5.5	36.2 ±0.2	13.5 ±0.1)	130.8 ±1.0	386.3 ±20.6	3.0 ± 0.6
	8.96	6.5	36.3 ±0.2	13.3 ±0.0)	130.5 ±1.9	3038 ±14.9	2.9 ±0.1
FLUEDUST	0.00	3.8	18.1 ±0.1	10.9 ±0.1)	89.0 ±5.8	148.5 ±23.6	1.3 ±0.3
	0.95	4.5	30.3 ±0.2	13.6 ± 0.1)	123.0 ±9.1	292.5 ±22.2	2.7 ±0.2
	2.24	5.5	41.4 ±1.0	13.8 ±0,1)	137.3 ±1.0	396.3 ±20.6	4.1 ±0.2
	6.20	6.5	42.9 ±0.6	13.9 ±0.1)	137.0 ±1.2	321.3 ±16.5	4.1 ±0.2
WOODASH	0.00	3.8	18.1 ±0.1	11.1 ±0.1)	89.5 ±5.3	151.3 ±23.9	1.4 ±0.2
	1.06	4.5	32.3 ±0.3	14.9 ±0.1)	130.8 ± 15.4	350.0 ±25.8	2.7 ±0.4
	2.80	5.5	40.1 ±0.1	16.8 ±0.2)	152.0 ±1.6	503.8 ±14.9	3.5 ±0.3
	7.50	6.5	40.1 ±0.1	15.9 ±0.1)	153.5 ±3.4	368.3±12.3	3.4 ±0.1
CALCIUM	0.00	3.8	17.5 ±0.1	11.0 ±0.1)	86.5 ±5.7	175.0 ±37.0	1.3 ±0.2
CARBONATE	0.78	4.5	36.5 ±0.3	13.5 ±0.0)	123.5 ± 7.9	301.5 ±18.4	2.7 ±0.1
	2.00	5.5	42.1 ±0.1	14.8 ±0.2)	128.0 ±1.6	382.5 ±33.0	3.0 ±0.2
	4.48	6.5	44.1 ±0.1	10.9 ±0.1)	134.5 ±3.4	281.3 ±22.5	3.9 ±1.1

*Values in parenthesis are Standard Error of the Means.

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Table 2c: Effect of Different Liming Materials on Nutrient Uptake by Soybean.

LIMING MATERIALS	Rates (Mg/h)	Soil pH Levels	Ca comlkg^{-1}	Mg cmolkg^{-1}	K cmol/kg^{-1}	P mgkg^{-1}	N g/kg^{-1}
SILICATE	0.00	3.8	15.1 ±0.1	10.9 ±0.1	71.9 ±0.1	147.5 ±5.0	1.6 ±0.2
SLAG	1.12	4.5	22.1 ±0.1	12.2 ±0.1	130.6 ± 1.0	288.8 ±21.1	2.4 ±0.4
	3.20	5.5	30.2 ±0.1	13.2 ±0.)	132.3 ±2.1	428.8 ±32.5	2.5 ±1.2
	8.96	6.5	31.2 ±0.1	13.1±0.1	132.5 ±1.9	290.0 ±18.3	3.0 ±0.1
FLUEDUST	0.00	3.8	15.1 ±0.1	11.1 ±0.1	74.8 ±18.6	1162.5 ±20.6	1.6 ±0.1
	0.95	4.5	26.3 ±0.1	13.2 ±0.1	137.0 ±1.8	311.3 ±13.2	2.7 ±0.2
	2.24	5.5	36.2 ±0.2	13.5 ±0.1	135.5 ±2.5	447.5 ±3.4	4.0 ±0.1
	6.20	6.5	38.2 ±0.2	11.1 ±0.1	13b.9 ±3.4	320.0 ±21.6	3.0 ±0.2
WOODASH	0.00	3.8	14.2 ±0.1	14.6 ±0.1	78. 3 ±20.2	147.5 ±20.6	1.5 ±0.1.
	1.06	4.5	30.2 ±0.1	15:4 ±1.0	142.3 ±2.1	395.5 ±7.5	2.5 ±0.0
	2.80	5.5	32.2 ±0.2	15.8 ±0.0	152.7 ±3.7	532.5 ±42.7	2.8 ±0.2
	7.50	6.5	34.1 ±0.3	11.1 ±0.1	19.6 ±1.7	137.5 ±38.1	3.0 ±0.1
CALCIUM	0.00	3.8	15.1 ±0.1	13.2 ±0.3	78.8 ±21.7	147.5 ±30.1	1.4 ±0.3
CARBONATE	0.78	4.5	31.4 ±0.1	14.2 ±0.1	130.3 ±3.9	292.5 ±8.7	2.7 ±0.1
	2.00	5.5	37.1 ±0.1	14.5 ±0.1	127.0 ±2.1	492.5 ±58.5	3.5 ±0.)
	4.48	6.5	39.1 ±0.1	14.6 ±0.1	133.0 ±1.2	295.0 ±30.0	3.4 ±0.2

*Values in parenthesis are Standard Error of the Means.

The rates of liming materials added that brought the Soil pH to 5.5 and above caused uptake of K to be significantly higher than both that of control and rate which raised Soil pH to 4.5 units. Uptake of k was not significantly different among the different legumes nor was this affected by the source of liming material used. There was no significant difference between crop uptake of K from woodash - treated Soil and Calcium Carbonate - treated Soil.

Liming an acid Soil with any of the materials used significantly improved both the uptake and utilization of Calcium (Ca) by all the indicator legumes. Highest uptake of Ca in each of the legume occurred when calcium Carbonate was the Source of liming material used. This was followed by fluedust treated Soil. Unlike K, additional supply of Ca through the liming materials influenced uptake of Ca by the legumes. Among the three legumes, uptake of Ca was highest in black-eyed bean and least in Sbyb.ean.

Crop uptake and Utilization of Mg was not significantly affected by either the rate or Sources of liming material added or by the Soil pH subsequently attained. At the highest rate of woodash addition, there was a slightly higher uptake of Mg by all the legumes used (Table 2a, b and c).

Minor Elements:Mn, Fe and Al^{3+}

Treating acid soils with different liming materials significantly affected plant tissue content of Mn in all the legumes used (Table 3). With increase in the rates of the liming materials added, the concentrations of Mn in the legumes were significantly reduced. Conversely, the plant tissue concentration of Fe was not significantly affected by liming even where Silicate Slag (high in Fe)

Table 3: Effect of liming an acid soil on Manganese (Mn), Iron (Fe) and Aluminum (Al^{3+})

LIMING MATERIALS	Rates (Mgh^{-1})	Mn ($cmolkg^{-1}$)	Fe ($cmolkg^{-1}$)	Al^{3+} ($cmolkg^{-1}$)
SILICATE SLAG	0	0.21 ± 0.1	0.14 ± 0.1	0.80 ± 0.3
	1.12	0.21 ± 0.1	0.15 ± 0.1	0.64 ± 0.2
	3.2	0.16 ± 0.2	0.14 ± 0.2	0.38± 0.1
	8.96	0.16 ± 0.2	0.14 ± 0.1	**NIL**
FLUEDUST	0	0.22 ± 0.2	0.14 ± 0.1	0.80 ± 0.3
	0.95	0.20 ± 0.2	0.12 ± 0.2	0.58 ± 0.2
	2.24	0.19 ± 0.1	0.11 ± 0.0	0.24 ± 0.1
	6.2	0.17 ± 0.1	0.09 ± 0.0	0.02 ± 0.0
WOOD ASH	0	0.21 ± 0.1	0.14 ± 0.2	0.80 ± 0.3
	1.06	0.21 ± 0.1	0.13 ± 0.3	0.64 ± 0.2
	2.8	0.19 ± 0.1	0.12 ± 0.2	0.38 ± 0.1
	7.5	0.16 ± 0.1	0.10 ± 0.0	0.02 ± 0.0
CALCIUM CARBONATE	0	0.21 ± 0.1	0.14 ± 0.2	0.80 ± 0.3
	0.78	0.20 ± 0.0	0.13 ± 0.1	0.62 ± 0.2
	2.0	0.12 ± 0.1	0.10 ± 0.1	0.32 ± 0.1
	4.48	0.06 ± 0.0	0.06 ± 0.0	0.04 ± 0.0

- Values in parenthesis are Standard Error of the Means.

was the source of liming material added. Liming an acid soil to pH of 6.5 units with the different materials used in this study reduced plant tissue concentration of Mn to less than 25% of the control treatment values. For example, addition of Calcium carbonate at the highest rate reduced plant tissue content of Mn to 0.92, 0.82 and 1.00 $cmolkg^{-1}$ for cowpea, blackeyed bean and soybean respectively.

DISCUSSIONS

Acidity and its attendant infertility problems in most Southwestern Nigeria soils, affect crop growth and yields adversely. The most certain managementapproach in solving this problem is the use of liming materials (Pearson, 1985). Thebenefit of using either conventional or unorthodox liming materialfor this purpose has been justified by some workers. Neilson *et al.*, (1991) and Yagodin (1984). Hence, Fluedust, woodash and silicate slag has been safely used as alternative sources of living material in this study for their nutrient supplying potentials as well as for economic reasons.

The results presented above confirm that all the test crops responded to the addition of liming materials used. The most probable reason for this could be the reduction in the levels of exchangeable Al^{3+} and other micronutrients that might be present in toxic concentration under acid soil condition. This consequently, enhanced root penetration and proliferation, increased microbial activities and population and eventually improve nutrient availability especially of N, P and S through organic matter decomposition. The end effect of these are: improved uptake and utilization of the essential elements, which stimulated vigorous crop growth and increased dry-matter yield. This is in line with some authors' opinion. For instance Kamprath (1970) had related the problems of acidity to the presence of Al^{3+} and Mn^{2+} at toxic concentration in soil. Janghorbani *et al*., (1975) has also observed that the availability of plant nutrients is greatly affected by the acid soil condition, He further observed the interaction between soil pH and soluble Al^{3+} on one hand andplant nutrients such as Mo, Mn, P, Ca, Mg, K, Fe, N, on the other hand. This interactions could be adverse under highly acidic conditions, which may lead to soilinfertility.

Liming enhanced dry-matter yield significantly to a point (pH 5.5) for lfe brown cowpea and blackeyed bean, beyond whichJhe.re was a reduction indry-natter yield. This reduction in dry-matter yield at soil pH 6.5 could be due to drastic reduction of some essential micronutrient elements. Black (1975) showed a reduction in solubility of all micronutrients except Mo thus resulting in a potential deficiency of Zn, Cu, Fe, Mn and B when soil pH was greater than 5.5. Increased concentrations of certain major nutrients also results from liming to high pH values. All these could have caused nutrient imbalance and hence yield reduction. Abangwe *et al.*, (1978) opined that liming tropical soils to pH values close to neutrality as practiced in temperate countries has been found not only to be uneconomical but could lead to yield depression. The relatively low dry-matter yield in the control treatment could he due to suspected Al^{3+} and Mn^{2+} toxicity, deficiencies of Ca, Mg, P and other adverse effects under acid soil condition.

There was a significant difference in dry- matter yield among crop species. Blackeyed beans for instance, produced the highest dry- matter yield of all the test legumes irrespective of the type liming materials added (Table 1b). The mean dry- matter yield of lfe brown cowpea (1.61g/pot) was 56% of that blackeyed bean (2.88g/pot). This difference was probably due to varying physiological demand for nutrients and their utilization among the three species. Their respective specie adaptation and response to acidity and liming could also have been different. In all however, blackeyed bean maintained the highest dry – matter yield for all treatments considered thus probably confirming its superiority as a locally adapted bean specie in this part of the World.The type of liming materials used significantly affected the dry – matter yield of crops even through with no consistent trend. This confirms the preferential specie response to the respective liming materials used.

Nutrients uptake was significantly influenced by the addition of liming materials irrespective of the sources. Also rate of application of the liming materials significantly affected uptake of N by the legumes but not beyond the rate that brought the soil pH to 5.5 units (Table 2a, b and c). As the rate of added liming material increased, the pH of the treated acid soil increased thus creating a conducive environment for microbial activities and population. The decomposition of organic matter and subsequent mineralization enhanced the release of nutrients especially N, P and S into solution thus making these elements available for crop uptake. Lack of difference in the uptake of N among the sources of liming materials may be due to the fact that no external addition of N was made nor was this element contained in any of the any of the liming materials added. The probable sources of N being taken up and utilized in this study were from those fixed by the legumes and through organic matter decomposition which was enhanced by liming the acid soil.

Plant tissue concentration of Mn which was significantly affected when soil was treated with the different liming materials. Concentration of Mn in the plant tissue tissue in the control treatment exceeded the threshold limit at which Mn toxicity occurred in most crop specie except for cowpea and soybean (Abangwu *et al*., 1978). Corresponding values in this study were 4.77, 4.80 and 4.80 cmolkg $^{-1}$ for lfe brown cowpea,blackeyed bean and soybean respectively. Although a concentration of 1.90 cmolkg^{-1} Mn in pea top was found to be toxic (White, 1970) and concentration of Mn greater than 1.70 cmolkg^{-1} was considered toxic to many plants (Jones, 1972). In this study however, the lowest level of plant tissue Mn contents after liming was 0.70 cmolkg^{-1} where wood ash was used. Although Juo and Uzu (1977) observed that Mn deficiency was limiting to the growth of maize in two acid Ultisols limed to soil pH of 7.1 units, it has been observed limiting to lfe brown cowpea, blackeyed bean and soybean in this study.

Conclusion

In conclusion, the waste used as liming materials in this study significantly increased the dry-matter yield of the three indicator legumes. Crop response to the added liming materials was due to the reduction in the levels of exchangeable Al and other micronutrients which might be in toxic concentration under acid Soil conditions.

Improved nutrient availability was enhanced through organic matter decomposition following the addition of the waste as liming materials. Crop uptake ofnitrogen was significantly increased by the addition of the liming material and rates ofapplication.

There was no difference among the legumes in the uptake of N. Rates of added liming materials significantly increased uptake of P. More P was taken from woodash, though not significantly so, than other liming materials. Also uptake of K and Ca but not Mg were significantly increased, by the addition of the liming materials. These increases in nutrients uptake was not beyond the rate of timing material addition that brought the soil pH to 5.5.

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