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Response of Sandy Clay Loam and Sandy Loam to Application of Fertilizer Types on Forms of Nitrogen, Phosphorus and Potassium

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ABSTRACT

Different soil textural classes release soil nutrients at different rates. Incubation study was carried out to compare the rate at which cattle dung (CD), NPK 15:15:15 and organomineral fertilizer (OMF) released forms of N, P and K to the soil in Idanre (sandy clay loam) and Okitipupa (sandy loam) in south west Nigeria. Two levels of CD applied at 2.5 and 5g, two levels of OMF at 2.5 and 5g; three levels of NPK at 0.5, 1 and 2g were respectively mixed with 1 kg soil and were incubated in the laboratory for 90 days. There was a soil sample without any treatment. The treatments were replicated three times and arranged on completely randomized design. Application of 5g/kg OMF recorded the highest total N in both soils. Application of CD at 2.5 and 5g kg^{-1} soil recorded the highest NH_4-N in both soils. 2.5g kg^{-1} OMF recorded the highest NO_3-N in Okitipupa while 5g OMF/kg soil had the highest NO_3-N in Idanre. Generally, the total N, NH_4-N and NO_3-N values in Okitipupa were higher than Idanre. 5g kg^{-1} soil samples had the highest soil total P in Okitipupa and Idanre. 2g kg^{-1} NPK had the highest available P in Okitipupa while 5g/kg OMF had the highest available P in Idanre. 5kg kg^{-1} OMF recorded the highest total K in the two soils. 2g kg^{-1} recorded the highest water soluble K in Okitipupa while 5g kg^{-1} OMF recorded the highest soluble K in Idanre.
KEY WORDS: mineralization, immobilization, incubation, ammonium nitrate, nitrate nitrogen

INTRODUCTION

Animal dungs, mineral and organomineral fertilizers are means of quick method of improving soil fertility in Nigeria. They readily supply nutrients especially N, P and K to the soil for immediate crop use. It is believed that the supply of plant nutrients by agro wastes, mineral fertilizers and their combinations interact differently in soil types because of their different characteristics and formulation. Sandy soils are known to be porous, loose, non-sticky, quickly respond to temperature change while clay soils particles are tightly packed, sticky, non-porous and difficult to work. The different characteristics exhibited by different soil structural units give rise to different interaction and the rate of nutrient release by the soils. Ayeni [1] observed that sandy soil, sandy clay loam, loamy sand and sandy clay reacts differently to application of organic manure, mineral fertilizer and their combination in an experiment conducted to determine the combined effect of cattle dung and urea fertilizer on organic carbon, forms of N and available P in selected Nigerian soils.

Also, fertilizer types react with the soils in different forms based on their nutrient content, quality and mode of their formulations. Agwarlu and Aseidu [2] opined that the use of plant and animal residues for soil fertility management would be more sustainable with minimum damage to the environment.

The use of cattle dung, NPK and organomineral fertilizers to improve soil fertility cuts across Nigeria (Ayeni, [1] . The rate at which these fertilizers release the essential plant nutrients to the soil for plant uptake have not been well researched in south west Nigeria. Hence, the objective of this study was to compare the extent to which cattle dung NPK and Organomineral fertilizers released forms of N, P and K to tow soils with different structural classes.

MATERIALS AND METHOD

Brief Description of Experimental sites

Okitipupa lies between longitude 4^o 3^5 and 6^o and 00^o E and latitudes 5^0 42^1 and 8^o and 55^1 North. The relative humidity is about 75% and has annual rainfall of about 2000mm per annum with mean temperature of about 27 ^{0}C. According to Obasi, [3], Okitipupa has rigdes, lagoon and sandy flats of sedimentary terrain signifying that the soil is dominated with hydromorphic soils. The pH of Okitipupa soils ranged 3.4 – 4.9 showing that the soils are mainly acidic. The inhabitants are good in oil palm farming. Okitipupa soil comprised 792, 120 and 388 g kg^{-1} sand, silt and clay respectively; thus it is sandy clay.

On the other hand Idanre lies between longitude 6^0 43^1N and 5^0 6^1E. It has high relative humidy but a bit lower than the humidity experienced by Okitipupa and has a rainfall of about 5,500mm per annum. Idanre is 425m above sea level and surrounded by hills [4] that are of tourist attraction. It is dominated with granite inselberges. Idanre lies within lowland forest that can be referred to as semi deciduous forest. Cocoa farming is

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the dominant occupation of the people. The textural soil of the site used for the experiment in Idanre comprised 720, 160 and 120 g kg^{-1} for sand, silt and clay respectively; thus it is sandy clay loam.

Soil Analysis

The soil samples were collected from farmers' fields in both Okitipupa and Idanre. Fifty core soil samples were collected from each location as representative samples. The soils were bulked, air dried and sieved through 2mm mesh.

2.5and5g of air dried cattle dung, 2.5 and 5g of organomineral fertilizer and 0.5,1 and 2g of NPK15:15:15 fertilizer was individually mixed with 1kg soil as treatments. Equal volume of distilled water was added to each treatment. The treatments were replicated three times and arranged on completely randomized design in the laboratory of the Department of Agricultural Science, Adeyemi College of Education, Ondo south west Nigeria.

The Soil samples used for chemical analyses were air dried by being spread out in a tray and placed in a forced air drying cabinet kept at around 35 °C The dried soil samples were ground in a roller mill and passed a 2-mm sieve to remove stones and unwanted debris [5] . Organic carbon was determined by the normal dichromate oxidation titration method. Total N was determined by the normal Kjedahl method.

The pH of the soil samples was determined in potassium chloride (KCl) and read with pH meter. The soil available P was determined by Bray 1 method. The amount of phosphorus extracted was determined by measuring the intensity of the blue color developed in the filtrate treated with molybadate- ascorbic acid reagent. The color was measured by a colorimeter at 880 nm. The result was reported in ppm. Digestion method was used to extract total phosphorus and solution phosphorus[6].

Nitrate (NO_3-N) and ammonium (NH_4-N) were extracted from 2g soil samples with 2.0 N KCl extracting solution and shaken for 55 minutes[7,8]. Nitrate was determined by reduction to nitrite. The absorbance of the product was measured at 520 nm. Ammonia was determined by heating with salicylate and hypochlorite in an alkaline phosphate buffer. Sodium nitroprusside was added to enhance sensitivity. The absorbance of the reaction product was measured at 660 nm. Exchangeable Potassium was extracted withneutral ammonium acetate and determine by AAS. Solution potassium was determined by Murphy and Riley procedure [6]. Digestion method was used to extract total P and determined by AAS while the exchangeable K was determined by flame photometer.

Statistical analysis

The data obtained were subjected to analysis of variance and least significant difference was used to separate the means. The soil pH was presented in graphical method.

RESULTS AND DISCUSSION

Compared to control, only 2.5 and 5g kg^{-1} OMF significantly increased soil pH and recorded the highest pH value in Okitipupa while there was no significant difference in pH among all the treatments in Idanre soil. The cations especially the Ca content present in cattle dung might not be sufficient to raise the soil pH; or the two soils especially Idanre soil might have high buffering capacity that resists change in the pH of the soils. The sources of organic materials used in the manufacturing OMF might contain high alkaline which might have detoxified the acid present in mineral fertilizer.

Generally, Idanre soil had higher soil pH in all the treatments except 2.5 and 5g kg^{-1} OMF. The Okitipupa soil type increased the pH of the soil treated with OMF to neutral level while 5g kg^{-1} CD increased pH to neutral level in Okitipupa. The total N and OC were generally low. Even, application of 2.5g kg^{-1} soil OMF could not raise the total N to 0.55% and 3% recommended as critical levels for southwestern soils.

There was no significant difference in soil OC and OC among the soil samples treated with 0, CD, OMF and NPK at all rates but the soil samples treated with CD had the highest OC in Okitipupa and Idanre. The C/N ratio was within the range that could enhance mineralization. The soil samples treated with 2.5 and 5g kg^{-1}CD in Okitipupa and Idanre significantly increased NH4-N compared with control. The level of increase in NH_4-N in soil treated with CD was sharp compared with all the treatments at the two locations with low conversion of NO_3-N. Organomineral fertilizer (OMF) and NPK fertilizer at all rates experienced faster conversion on NH_4-N to NO_3-N compared with control and CDat all rates. The soil conditions at the two sites might have favoured ammonifying bacteria than nitrifying bacteria[9,10, 11]. The rapid mineralization of NH_4-N to NO_3-N might have led to little or no difference in pH of the treatments compared with control. Ammonium nitrate is acidic in nature which might not favour increase in soil pH. Many soil fertility researchers who worked on mineral fertilizers such as NPK 20:10;10, Urea and Calcium ammonium nitrate found that these fertilizers reduce soil pH (Ayeni, 2010).

Compared with control, all the treatments significantly increased soil NO_3-N but 2.5g kg^{-1} OMF recorded the highest NO_3-N. It seemed the rate of conversion of NH_4-N to NO_3-N was low in soil samples treated with CD compared with OMF and NPK. The varied C/N of the treatments might have affected N mineralization because the higher the C:N ratio, the slower the N mineralization [10]. The outstanding increase in NO_3-N among the treatments especially OMF was spectacular. This shows that there was rapid conversion of NH4-N to

NO_3-N in all the treatments. Applied OMF at 5g kg^{-1} recorded the highest NH_4-N+NO_3-N in Idanre while 2.5OMF recorded the highest NH_4-N and NO_3-N in Okitipiupa showing that some soil physical properties especially the textural classes have impacts on nutrients mineralization when fertlizers are applied. Also, the rate of NH_4-N mineralization to NO_3-N in Okitipupa was faster than Idanre showing the difference in the way which sandy loam and sandy clay respond to the treatments. Three months might have been sufficient for the conversion of organic N present in CD to inorganic form [12] . The higher increase in inorganic N present in 5g kg^{-1} CD than 2.5g kg^{-1} CD might as a result of higher amount of N present in 5g kg^{-1} CD than its corresponding 2.5g kg^{-1} CD.

Relative to control, all the treatments significantly increased soil total Pexcept the soil samples treated with 2.5g kg^{-1} CD and 0.5g kg^{-1} NPK fertilizer in Okitipupa (Table 2). The total P of the soil samples treated with 2.5 and 5 g kg^{-1} CD; and 0.5 and 1 g kg^{-1} NPK were not significantly affected in Idanre soil. The soil samples treated with 5g kg $^{-1}$ CD was the only treatment that was significantly increased in totalP in Okitipupa while 0. 5 g kg^{-1}NPK was not significantly increased in total P in Idanre soil. Compared with the control experiment, all the treatments significantly increased available P except 0.5g kg^{-1} NPK in both Okitipupa and Idanre soils.

Despite the fact that the total P in the control experiment in Idanre soil samples was lower than the total P in Okitipupa soil samples, there was still higher increase in total P of Idanre soil samples when compared with treated soil samples of Okitipupa showing that Idanre soils adsorbed more P than Okitipupa soils. This could be easily explained by the percentage change in the total P of both locations. Compared with control, 2.5 and 5 g kg^{-1} CD of Okitipupa had 7 and 9% increase in total P while Idanre soils had 10 and -5% change in Idanre (5g kg^{-1} CD even reduced total P in Idanre soils). Application of 2.5 and 5 g kg^{-1} OMF increased total P by 42 and 25% in Okitipupa while Idanre recorded 70 and 12% respectively. For NPK fertilizer 0.5 and 1 g kg^{-1}, total P was increased by 24 and 22% in Okitipupa while 1 and 2% were respectively recorded for total P in Idanre . Also, the level of available P in all the treated soil samples in Idanre soils were higher than Okitipupa soil samples, whereas reverse was the case in water P. In available P, Okitipupa soil samples recorded percentage increase of 30, 50, 36, 30, 4,23 and 44 for 2.5CD, 5CD, 2.5OMF, 5OMF, 0.5NPK, 1NPK, and 2NPK(g kg^{-1}) respectively while 32, 46, 68, 107, 4, 38 and 51% increase were recorded for 2.5CD, 5CD, 5OMF 2.5OMF,0.5NPK, 1NPK, and 2NPK g kg^{-1} respectively in Idanre soils . Considering the available P, it seems soil fixes P in Okitipupa more than Idanre except the soil samples treated with CD.

Water P in Okitipupa soil samples was higher than water P in Idanre soil samples treated with 2.5 and 5 g kg^{-1}CD; 2.5 g kg^{-1} OMF, 0.5 and 2 g kg^{-1} NPK fertilizer. For water P percentages of 5, 124, 25,3,6,9 and 8 in Okitipupa soils for 2.5CD, 5CD, 2.5OMF, 5OMF, 0.5NPK, 1NPK, and 2NPK g kg^{-1} respectively while percentage change of 27, 107, 59, 104, 10, 36 and 136 were recorded for 2.5CD, 5CD, 2.5OMF, 5OMF, 0.5NPK, 1NPK, and 2NPK g kg^{-1}respectively.

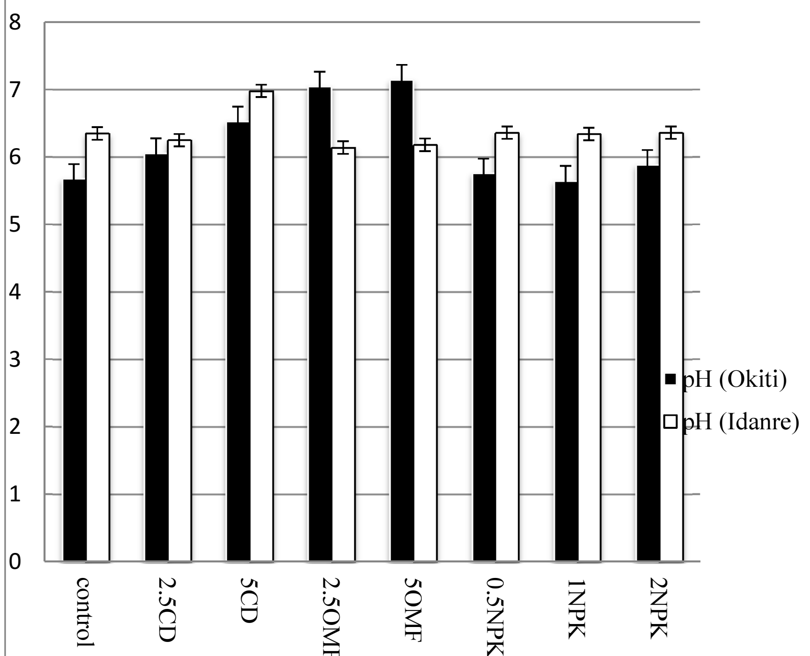

Figure 1: Comparative effect of cattle dung, manufactured organomineral and NPK fertilizer on soil pH (Treatments are in (g kg^{-1})

Table 1: Comparative effect of cattle dung, organomineral and NPK fertilizers on soil forms of N and OC

Treatment	Okiti	Idanre	Okiti	Idanre	Okiti	Idanre	Okiti	Idanre
	Total N	Total N	OC	OC	NH_4-N	NH_4-N	NO_3-N	NO_3-N
	%				____________mgL^{-1} ___________			
Control	0.07	0.04	0.85	1.14	37.72	97.04	101.1	18.64
2.5CD	0.09	0.05	1.03	1.8	347.49*	159.09*	262.3*	28.48*
5CD	0.09	0.06	1.08	1.83	407.08*	173.09*	301.4*	37.39*
2.5OMF	0.11	0.08	0.95	1.7	43.39	164.45*	609.14*	33.89*
5 OMF	0.12	0.1	0.8	1.81	41.22	170.45*	442.8*	44.67*
0.5 NPK	0.07	0.04	0.86	1.13	39.1	100	121.21*	20.33
1 NPK	0.08	0.05	0.87	1.15	40.9	160.43*	321.12*	35.13*
2 NPK	0.11	0.05	0.88	1.18	39.77	167.39*	375.9*	42.13*
LSD 0.05	ns	ns	ns	ns	13.56	9.88	20.12	3.12

Table 2: Comparative effect of cattle dung, organomineral and NPK fertilizers on soil phosphorus

Treatment	Total P		Water P		Available P	
	Okiti	Idanre	Okiti	Idanre	Okiti	Idanre
	Mg L^{-1}					
Control	120.50	752.9	12.13	23.77	40.64	32.02
2.5 CD	128.60	760.2	11.39	30.20*	53.01*	42.24*
5 CD	179.23*	749.3	27.27*	49.27*	61.09*	46.77*
2.5 OMF	170.76*	789.9*	9.11	37.89*	55.06*	53.67*
5 OMF	150.08*	814.4*	12.48	48.59*	52.71*	66.44*
0.5 NPK	128.60	744.5	12.87	26.13	42.11	33.04
1 NPK	149.70*	764.15	11.10	32.43*	50.00*	44.17*
2 NPK	146.41*	784.0*	11.12	56.14*	58.32*	48.33*
LSD 0.05	11.08	13.21	3.01	5.65	4.02	3.44

In Okitipupa, 5g CD soil, 2.5 and 5g OMF, 1 and 2g kg-1 NPK fertilizer significantly increased soil total K; all the treatments significantly increased solution K (except 500kg NPK fertilizer) and available K compared with control. In Idanre, all the treatments significantly increased total K, solution K and exchangeable K. The K in Okitipupa had medium to high exchangeable K while the exchangeable K was quite high in Idanre. The high K in Idanre soil might be as a result of its parent material that is rich in K.

Table 3: Comparative effect of cattle dung, organomineral and NPK fertilizers on soil exchangeable potassium

	Okitipupa	Idanre	Okitipupa	Idanre	Okitipupa	Idanre
Treatment	total K		Water K		Exchangeable K	
			Mg L^{-1}			
Control	509.8	74.78	35.92	520.54	575	254.50
2.5CD	200.1	250.57*	92.48*	525.44	226	357.43*
5CD	595.6*	235.55*	85.60*	577.46*	479	473.45*
2.5OMF	256.4	258.04*	532.08*	349.21	252	575.05*
5OMF	556.1*	307.66*	533.25*	427.85	232	703.85*
0.5NPK	558.22*	500.04*	450.00*	526.63	598	222.54
1NPK	544.9	240.5*	452.00*	206.00	200	542.3*
2 NPK	585.4*	243.43*	435.00*	399.42	206	705.4*
LSD 0.05	55.08	52.52	23.04	59.55	ns	53

Conclusion

Experiment was conducted to compare effects of cattle dung, organomineral and mineral fertilizers on soil properties in southwestern Nigeria. Generally, organomineral recorded highest total N, NO_3-N in both Okitipuoa and Idanre, total P and available P in Idanre alone and water P in Okitipupa. The highest increase in OC in both Okitipupa and Idanre . Application of cattle dung had highest increase in OC, NH_4-N and water P. cattle dung also had the highest amount of total P, total K and water K in Okitipupa. NPK fertilizer had highest total K in Idanre and exchangeable K in Okitipupa. In respect to these assertions, Organomineral fertilizer is liable to releasing N and P that can cause pollution either by denitrification or by leaching into water than cattle dung and NPK fertilizer in both sandy clay and sandy clay loam.

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REFERENCES

1.Ayeni, L.S 2012. Combined effect of cattle dung and urea fertilizer on organic carbon, forms of N and available P in selected Nigerian soils. Journal of Central European Agriculture, 53 (3): 605 – 607

2.Agyarko, K and Asiedu E.K. 2012. Cocoa husk and poultry manure on soil nutrients and cucumber growth. Advances in Environmental Biology. 6 (11): 2870 – 2874

3Obasi, R. A.2013. Vulnerability of Soil Erosion in Okitipupa Area of Ondo State, SouthwestNigeria: A Climatic Problem. International Journal of Science and Technology Volume 2 No. 4, April, 2013: 326 – 335

4.Aikpokpokdian, P.E.2010.nutrients dynamics in cocoa soils, leaf and beans in Ondo state, J agric. Sc 1 (1): 1-9

5.Metson, A.J. 1975. Methods of Chemical Analysis for Soil Survey Soils.New Zealand Soil Bureau Bulletin 52.

6. Murphy, J., Riley, J.P. (1962) A modified single solution method for the determination of phosphate in natural waters. *Anal.Chim.Acta*27: 35-36

7.Keeney, D. R. and Nelson, D. W. 1982. Nitrogen-inorganic forms. pp. 643-698. In: A. L. Page (ed.) Methods of soil analysis: Part 2. Chemical and microbiological properties. ASA Monograph Number 9

8.Hofer, S. 2003. Determination of Ammonia (Salicylate) in 2M KCl soil extracts by Flow Injection Analysis. QuikChem Method 12-107-06-2-A. Lachat Instruments, Loveland, CO.

9.D. Horneck, A. D. M. Sullivan, J. S. Owen, and J. M. Hart 2011. Soil Interpretation Guide, Oregon State University Extension Service.

10.Samuel, L.T;L.NWernner; D.B.James and L.H John. 2003. Soil Fertility and Fertilizers. 5th Edn.Prentice Hall, New Jersey, USA.Pp 634

11.Agbede O.O. 1984. Mineralization of N in soils with varying C/N ratios and Fertility levels. Nigeria. Journal of.Agronomy. 1 (3) : 92 - 96

12. Ayeni,L.S., 2011. Combined Effect of Cattle Dung and Urea Fertilizer on Organic Carbon, Forms of Nitrogen and Available Phosphorus in Selected Nigerian Soils.Journal of Central European Agriculture, 2012, 13(3), p.610-616 DOI: 10.5513/JCEA01/13.3.1098