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EFFECTS OF LIMING ON SOME PROPERTIES OF SOUTH EASTERN SOILS OF NIGERIA

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ABSTRACT

Liming with agricultural lime was carried out at some locations in the old South-eastern part of Nigeria. One hectare each was acquired at Akpabuyo (Cross River State), Calabar (Cross River State), Amakama (Abia State) and Igbariam (Anambra State) in August 2008. The plots were cleared, treated with 1.6 tons of agricultural lime and properly mixed by ploughing and harrowing up to 20 cm depth. The plots were planted to maize (Oban I variety) after four weeks of incorporating the lime followed by intercropping with cassava (TMS 30572), after two months of planting maize.

In the second year (2009), the same plots were prepared and planted with maize and cassava consequently to investigate the effects on the yields of the crops with soil parameters also collected after harvesting. The results showed that lime greatly influenced the chemical and biological properties but had little effects on the physical properties of the soils even at the end of the second season. There was no significant influence of the liming on the yields of the crops in the first year, but significance was noticed after the second planting. The soils' chemical and biological properties were significantly affected after the second planting. Agricultural limes when applied to the soil improved the chemical, biological and physical properties of the soils, as well as the yields of acid sensitive crops.

Keywords: Liming, Agricultural lime, Soil properties, Soil parameter and Crop yields.

INTRODUCTION

Liming is the application of calcium and magnesium-rich materials to the soil in various forms, including Mari, chalk, Hydrated lime to neutralize the soil acidity and to increase the activity of soil microorganism (Paul 2002). Agricultural limes (limes) are also those compounds which are used or applied to alter (or increase) pH values to desirable levels, or to correct soil acidity problems (George, 2009). The application of lime to agricultural soils can affect biological, chemical and physical properties of the soils. The finding of Morris (2008), also recorded that the increase in soil pH resulting from the application of lime provides a more favourable environment for soil microbiological activities which increase the rate of release of plant nutrients. He further stated that reduced soil acidity following liming also increase the availability of several other plant nutrients, notably phosphorus (P). Only about 20 % of fertilizer phosphorus is taken up by crop in the year of application, the remainder is fixed in the soil in various degrees of availability to succeeding crops. In acid soils, the fixed phosphorus is retained in less available forms than a slightly acid and neutral soil.

Less seems to be known about the effect of lime on the physical properties of soils than on the chemical properties. There are several reasons for this; first, changes in physical properties of soils are more gradual than most chemical changes. Secondly, many physical properties of a soil which exist in-situ simply do not exist when the soil is disturbed (Grey 2010).

The pH level of the soil governs a lot of factors and therefore, has a great impact on bacterial growth. Hence, even minor changes in the soil pH can drastically affect the diversity of soil bacteria. Liming increases the population of earthworms, redistribute organic material within the soil, increase soil penetrability and under certain conditions, influence ion transport in the soils. Root distribution may be modified and microbial activity increases by the burrowing and feeding activities of earthworms. Earthworms according Ebong (2007), influence the supply of nutrients in several ways by which liming increases the population of microbes and earthworms thereby improving the organic matter content of the soil.

Liming generally has effect on both macro and micro elements, as well as on the water use efficiency of crops. Therefore, the investigation was carried out on some South-eastern soils to determine the effect of liming on the physical, chemical, biological properties as well as to determine the yield of acid-sensitive crops as a measure to alleviate the problem of acidity in South-eastern soils.

MATERIALS AND METHODS

The research was conducted at different locations: Akpabuyo (Cross River State), Calabar (Cross River State), Amakama (Abia State), Igbariam (Awka Local Government Area of Anambra State). Abia is located within the latitude 4^0 N 4’, and 14^0 N 6’, longitude 10^0 W 7’ and 8 ^{0}E. Anambra State is located within the latitude 4^0 N 45’ and 7^0 N 15’, longitude 6^0 E 50’ and 7^0 E 25’. Cross River is located within latitude 4^0 N 4’ and latitude 5^0 N 2’, and longitude 8^0 E 0’ and 8^0 E 3’.

In Abia State, the relative humidity, annual rainfall and average temperature range between 65-70 %, 1600-1900 mm, 20-28 ^{0}C respectively. In Anambra State, they range between 64-80 %, 1900-2000 mm, and 22-29 ^{0}C respectively. In Cross River, they range from 75-85 %, 2100-3500 mm, and 21-29 ^{0}C.

Sample Collection

Samples were collected from the different locations to a depth of 0-20 cm using a soil auger. The samples were properly labeled and prepared for microbial and physico-chemical analysis in the laboratory. The samples for physico-chemical analysis were air-dried, crushed with mortar and sieved through a 2 mm-sized sieve to get the fine fraction. The ones for microbial analysis were kept in a cooler containing ice block, and carried to the laboratory for microbial analysis.

Cultivation of the Crops (Maize and Cassava)

The plots (one hectare size) at the various locations were treated with 1.6 tons of agricultural lime and properly mixed by ploughing and harrowing up to 20 cm depth. The plots were planted to Maize (Oban 1) variety after four weeks of incorporating the lime at a spacing of 75 cm by 25 cm with a plant population of about 53000 stands. This was followed by intercropping with Cassava (TMS 30572 variety) at a spacing of 1m by 1m after two months of planting Maize.

Laboratory Analysis of Samples

The physical and chemical analysis were done in the laboratory as follows: Soil pH was determined in soil water solution in the ratio of 1:2. Organic carbon was determined by the Walkley-Black method. Total N by the Kjeldhal digestion, exchangeable bases through extraction with 1N NH_4OAc, Ca and

Mg were read in an AAS while K was through flame photometry.

The standard procedures as contained in the method of soil analysis by Black *et al.* (1965) were employed for the Analysis. Descriptive statistics was used to analyze all the data obtained.

RESULTS AND DISCUSSION

The results obtained from the soil physical analysis before treatment with lime are given in Table 1a. The texture of the soil varies from sandy loam to loam with generally high silt contents and high clay content. Silt ranged from 15.0 – 42.2% and clay ranged from 1.8 – 46.2% and sand ranged between 28.4 -67.2%.

Table 1b also indicated similar trend even after treatment for two years.

Table 2a shows the chemical properties of the soil before treatment with lime, the chemical properties indicate some upward changes due to the effects of lime application as shown in Table 2b. The pH value of the soil varies between 5.4 - 5.9 which shows acidity. The value of organic carbon also changes due to decomposition processes that came up as a result of lime application. All the chemical parameters are affected with time from 2008-2010.

Table 3a and 3b compared the exchangeable cation before and after treatment, there was a drastic improvement in the parameters considered after one and two years treatment.

Table 4a indicates the biological, properties (bacteria) before treatment, when compared with Table 4b it shows some increase in the population and activities of bacteria in the soil which is comparable to Bagyaraj 1994 findings that the activities of bacteria increase with lime application.

The same thing applied to the population of fungi in the field as shown on Table 5a and 5b compared.

In Table 6a and 6b compared there was an improvement in the yield of the test crops; Maize and Cassava after two years of application of lime, the yield increased significantly.

In conclusion the results show that the lime greatly influenced the chemical and biological properties of soils with time but had little effects on the physical properties of the soils even at the end of second season. There was no significant influence of the lime on the yields of the crops in the first year, but the significance was noticed after the second planting. Agricultural lime when applied to the soil improved the chemical, biological and physical properties as well as the yields of acid sensitive crops.

Table 1a: Physical characteristics (particle size analysis) (pre-treatment)

Location	Clay (%)	Silt (%)	Sand (%)	Textural Class
Akpabuyo (Cross River)	14.2	15.0	70.8	Sandy clay
Calabar (Cross River)	13.8	14.0	73.2	Loam
Amakama (Abia)	12.2	14.5	73.3	Sandy clay
Igbariam (Anambra)	16.0	17.2	66.8	Sandy loam

Table 1b: physical characteristics (particle size analysis) (post-treatment)

Location	Clay (%)	Silt (%)	Sand (%)	Textural Class
Akpabuyo (Cross River)	14.2	16.0	71.8	Loam
Calabar (Cross River)	14.8	15.0	71.2	Sandy clay
Amakama (Abia)	11.7	14.0	74.3	Loamy sand
Igbariam (Anambra)	15.0	16.2	68.8	Sandy clay

Table 2a: Chemical Properties Of The Soil (Pre-Treatment)

Location	Soil reaction (pH)	Organic carbon (%)	Available Phosphorus (g/kg)
Akpabuyo	5.0	0.04	17.75
Calabar	5.1	1.29	22.75
Amakama	5.2	2.21	11.70
Igbariam	5.3	1.69	12.50

Table 2b: Chemical Properties Of The Soil (Post-Treatment)

Location	Soil reaction (pH)	Organic carbon (%)	Available Phosphorus (g/kg)
Akpabuyo	5.6	0.08	31.65
Calabar	5.4	2.59	32.63
Amakama	5.8	2.71	22.50
Igbariam	5.7	2.79	27.63

Table 3a: Exchangeable Cations (Pre-Treatment)

Location	Ca+ (Cmol/kg)	Mg+ (Cmol/kg)	K+ (Cmol/kg)	Na+ (Cmol/kg)	H+	Al3+	ECEC (Cmol/kg)	BS (%)
Akpabuyo	4.6	1.0	0.11	0.09	1.48	2.2	9.48	61.1
Calabar	3.6	4.6	0.09	0.07	0.24	1.16	9.76	85.7
Amakama	6.2	3.0	0.11	0.09	0.56	2.52	12.48	75.3
Igbariam	5.8	2.4	0.10	0.08	0.80	0.68	7.86	71.17

Table 3b: Exchangeable Cations (Post-Treatment)

Location	Ca+ (Cmol/kg)	Mg+ (Cmol/kg)	K+ (Cmol/kg)	Na+ (Cmol/kg)	H+	Al3+	ECEC (Cmol/kg)	BS (%)
Akpabuyo	5.6	3.6	0.12	0.09	0.6	1.88	10.89	77.2
Calabar	6.3	5.9	0.10	0.07	0.4	1.96	11.73	79.8
Amakama	6.4	6.2	0.10	0.11	0.68	2.08	11.54	76.0
Igbariam	6.7	4.8	0.12	0.11	0.76	1.12	11.79	73.88

Table 4a: Microbial (Bacterial) Count of the Soil Samples (Pre-Treatment)

Location	Bacterial count
Akpabuyo	59×10^6
Calabar	137×10^6
Amakama	83×10^6
Igbariam	46×10^6

Table 4b: Microbial (Bacterial) Count Of The Soil Samples (Post-Treatment)

Location	Bacterial count (2009)	Bacterial count (2010)
Akpabuyo	279×10^6	300×10^6
Calabar	49×10^6	70×10^6
Amakama	54×10^6	66×10^6
Igbariam	95×10^6	102×10^6

Table 5a: Microbial (Fungi) Count For The Soil Samples (Pre-Treatment)

Location	Fungal count (cfu/g)
Akpabuyo	18×10^3
Calabar	22×10^3
Amakama	54×10^3
Igbariam	29×10^3

Table 5b: Microbial (Fungi) Count For The Soil Samples (Post-Treatment)

Location	Fungal count (cfu/g) (2009)	Fungal count (cfu/g) (2010)
Akpabuyo	15×10^3	20×10^3
Calabar	54×10^3	55×10^3
Amakama	34×10^3	36×10^3
Igbariam	31×10^3	34×10^3

Table 6: Yield Data Of Maize And Cassava

Location	Maize yield (t/ha) (2009)	Cassava yield (t/ha) (2009)	Maize yield (t/ha)(2010)	Cassava (t/ha) (2010)
Akpabuyo	1.5	12	1.8	15
Calabar	1.4	11.9	1.6	20
Amakama	1.8	15	2.2	18
Igbariam	1.7	17.2	2.1	22.2

REFERENCES

Amos, I.M. (2001). *The Organic content of the soil. Kaduna Nigeria*. Kabbir Press, Pp. 204-227

Barnes, A. U. (2004). *Determination of Effective Cation Exchange Capacity of South-Eastern Soils of Nigeria*. Enugu, Nigeria Macmilian Press. Pp 905-916.

Baygyajai, A. H. (1994). *The Determination of Exchangeable Cations of Agricultural soils.* Bombay, India Rahman, India Jera consults, pp. 330-372

Brown, P.V. (2001). *The microbial analysis of soil samples in the tropics, Accra, Ghana* Melgir Press, Pp 20-98

Brown, W. P. (2010). *The Application of Limes to Agricultural soils in Tropical Africa*, Lime, Togo Palson Publishers, Pp 103-161.

Chapman, N.R. (1991). *The importance of Agricultural Limes to soils in West Africa* Accra, Ghana Malgins Press, Pp 84-92.

Charles, P.O. (1998). *The usage of Agricultural Limes in improving soil fertility*. *Ibadan, Nigeria* University Press, Pp. 206-232.

Day, P.O. (1998). *The Physical analysis of soil particles* New York University Press, New York, USA Pp 116-220.

Ebong, O. M. (2007). *Rural Agricultural Development in Nigeria, Ikot Ekpene, Nigeria* Okonson Publishers, Pp. 118-161.

Francis, J.r. (2006). *The Effects of Liming on the physical properties of soils of South-Eastern Nigeria Nigeria*. Lagos-Nigeria, Nelson Publishers Pp. 210-223.

George, O. O. (2009). The influence of Liming on Agricultural Soils in Tropical Africa. Lagos. Nigeria Nelson Publishers. Pp. 216-281

Ghapman, R. Y. (1990). *The Determination of Exchangeable Bases in Agricultural Soils.* Melborne – Australia. Carris Press, Pp. 338-367.

Gibson, G. P. (1996). *The Determination of the soil Reaction of Agricultural soils*. New York, USA. New York University press Pp. 46-81.

Godwin, M.S. (2006). *The Effects of Agricultural Limes on the physical and chemical properties of South-Eastern soils of Nigeria.* Aba, Nigeria. Emeka Publishers, Pp. 96-113.

Grey, P.M. (2010). *The importance of Agricultural Limes to the soils of South-Eastern Nigeria. Lagos-Nigeria*. Ogun Press. Pp. 425-453.

Jackson, M.N. (1999). The Laboratory Analysis of Organic Carbon content of soils. London, United Kingdom. Marshall Publishers. Pp 291-331.

James, S.P. (1999). The Effects of Liming on the *Chemical Properties of soils in South-Eastern part of Nigeria. Umuahia*, Nigeria. Nkems Press, Pp. 56-82.

Landon, M. O. (1991). *The Determination of Chemical properties of soils*. Califonia USA. Jens Press. Pp. 116-219.

Maxwell, M.C. (2001). *The Laboratory Analysis of Exchangable Acidity in Agricultural Soils.* Liverpool, United Kingdom. Charles & Sons Press. Pp. 201-223.

Melson, P. R (2002). The Determination of Available phosphorus in Agricultural soils. Churchill, New Zealand Henris Press, Pp. 57-96.

Mike, S.S. (2005). *The improvement of Acidic soils in Tropical Africa*. Lime, Togo Cataian Publishers. Pp. 66-89.

Morris, C. B. (2008). *The effect of conventional liming on soils in South-Eastern Nigeria.* Nsukka, Nigeria Chuks Publisher, Pp.101-201.

Paul, M. T. (2002). *The Effects of Agricultural Limes on the Biological Properties of soil.* Los Angeles, Carlifonia, USA. Katy publishers, Pp 204-213.

Paulsen, I. P (2007). *The Consequences of liming on the soils*. Accra, Ghana, Wenson & Sons Press. Pp 218-224.