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Effect of Hydrated Lime on the Growth of Maize at Federal Capital Territory, Abuja

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Abstract: A 4×4 factorial experiment in a Randomized Complete Block Design (RCBD) with three replicates was used to study the effects of hydrated lime on the growth of maize crop at National Special Programme for Food Security (NSPFS) field FCT, Abuja. The results showed that all fertility related properties of the soil were low with moderate to slightly acidity and the exchange site saturated with H^+. 0.25 ton ha^{-1} of hydrated lime+0.25 ton ha^{-1} of NPK 15-15-15+2 ton ha^{-1} of Farm Yard Manure (FYM) incorporated into top soil increased the growth of maize more significantly than either 0.5 ton ha^{-1} of hydrated lime or zero lime. Therefore, on the average 0.55 ton ha^{-1} of lime was recommended for the site.

Key words: Hydrated lime, acidity, liming requirement, maize, farm yard manure

INTRODUCTION

There is a growing recognition, among both specialists and policy-maker that soil degradation is one of the root causes of declining agricultural productivity in sub-Saharan Africa, (SSA) in particular Nigeria and that, unless controlled, would suffer increasingly from food insecurity. Soil acidity is one of the major constraints to crop production in humid tropical region. This is due to the usual accompanying effects of Al and Mn toxicity and nutrient deficiencies and their consequential detrimental effects on crop growth and yield (Oguntoyinbo *et al*., 1991). Liming has long been recognized as an important way of ameliorating soil acidity. Chude *et al*. (2004) opined for maximum growth, plant require high level of nutrients, the availability of which is curtailed when the soil is acidic. However, certain micronutrient particularly (Zn and Cu) result in yield depression when the soils are over-limed. Therefore, application of soil amendments such as hydrated lime and Farm Yard Manure (FYM) have strong ability to raise the buffering capacity of the soil becomes a necessity. Farm yard manure help to neutralize soil acidity, it could also provide some essential micronutrients such as Zn, B, Cu etc., for crop production (Adetunji, 1997). Hydrated lime apart from correcting soil acidity, it also aid in releases soil P that is most limiting in tropical soils.

Much literature on complementary effect of organic and inorganic fertilizer on crop yield but little attention has been placed on management of soil acidity in highly weathered savannah soils with liming. Furthermore, it is necessary to understand the efficiencies of integrated nutrient management in managing this acidic soil. Therefore, the objectives of this study were to:

- To determine the relative effectiveness of different rates of hydrated lime and fertilizer compared to the absolute control.
- To study the effect of agronomic and economic optimum of hydrated lime on maize production in acid soil.

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MATERIALS AND METHODS

The study was carried out at National Special Programme for Food Security (NSPFS) irrigation research field in Kwali Gwagwalada Federal Capital Territory (FCT), Abuja during the 2005 dry season farming. The fields were ploughed and harrowed to a fine tilt and marked out into plots of 2×2 m. Composite soil samples (0-20 cm) were taken for analysis for texture, pH, organic carbon, total N, available P, Boron and exchange K (Page *et al*., 1982).The experiment was laid in a randomized complete block design replicated thrice. There were 4 treatments: T1 = zero lime and fertilizer; T2 = zero lime, 0.25 ton ha^{-1} of NPK 15-15-15 and 2 ton ha^{-1} of farm yard manure; T3 = 0.25 ton ha^{-1} of hydrated lime, 0.25 ton ha^{-1} of NPK 15-15-15 +2 ton ha^{-1} of FYM; T4 = 0.5 ton ha^{-1} of hydrated lime +0.25 ton ha^{-1} of NPK 15-15-15+2 ton ha^{-1} of FYM which were factorial combined. The extra-early maize (variety across 94) was used as a test crop. Quantities of both fertilizer and lime were incorporated into 5 cm depth of the soil. The plots were watered at field capacity level for 9 days. At the end of the ninth days, 4 seeds of extra early maize were planted at a spacing of 30x30 cm and later maintained 2 plants/stand after thinning. Percent germination was observed daily from fourth day after planting till the ninth day when 99% germination was recorded. Beginning from tenth day after emergence, observations were taken at interval of 2 weeks on: plant morphology; leaf number; plant height. Plant height was measured from the soil surface to the whorl using a meter rate while the leaves were counted. After 9 weeks of growth in the field, the plants were harvested, cobs removed and the grain yield was taken. The data collected were subjected to analysis of variance and difference between means was separated using the Least Significance Difference (LSD 0.05).

RESULTS AND DISCUSSION

The sample site was located in a low land area, shallow and moderately deep to deep well drained and some what poorly to poorly drained sandy loam and sometimes gravely surface over sandy clay loam to clay loam and sometimes gravelly subsoils. The soil has been classified as Ultisols (Table 1). The composite surface soil samples revealed the pH to be moderately to slightly acidic on the whole. This affirmed the findings in Northern Nigerian savannah soils. The fertility related properties are generally limited in the soils except available P that have relatively higher in some plots, this may

Table 1: Physical properties of soil samples of the trial area, FCT Abuja

	Particle size distribution (%)			
Soil sample	Clay	Silt	Sand	Textural class
1	21	7	69	Sandy clay loam
2	23	14	63	Sandy clay loam
3	24	10	66	Sandy clay loam
4	20	7	73	Sandy loam
5	19	10	71	Sandy loam
6	19	10	71	Sandy loam
7	18	8	74	Sandy loam
8	16	8	76	Sandy loam
9	38	26	36	Clay loam
10	19	16	65	Sandy loam
11	17	18	65	Sandy loam
12	26	9	65	Sandy clay loam
13	15	12	73	Sandy loam
14	23	10	67	Sandy clay loam
15	25	12	63	Sandy clay loam
16	24	9	67	Sandy clay loam

Table 2: Chemical properties of soil samples of the trial area, FCT Abuja

Soil sample	pH (H_2O)	Organic carbon (%)	Organic matter (%)	Nitrogen (%)	K (Cmol kg^{-1})	AL3 (Cmol kg^{-1})	Zinc (mg kg^{-1})	Boron (mg kg^{-1})	Phosphorus (mg kg^{-1})	Classification of Acidity	Lime requirement (tha^{-1})
1	5.92	0.24	0.42	0.02	0.27	0.04	0.20	0.11	17.66	Moderate Acidity	0.594
2	6.36	0.66	1.14	0.06	0	0.06	0.75	0.07	2.14	Slight Acidity	0.495
3	6.47	0.41	0.71	0.04	0.24	0.02	0.50	0.07	18.19	Slight Acidity	0.429
4	5.60	0.24	0.42	0.02	0.46	0.02	0.05	0.08	37.45	Moderate Acidity	0.594
5	6.01	0.23	0.40	0.02	0.33	0.02	0.05	0.07	1.61	Slight Acidity	0.561
6	7.05	0.75	1.29	0.07	0.39	0.02	0.85	0.09	0.54	Slight Alkalinity	0.165
7	6.12	0.28	0.48	0.02	0.2	0.04	0.45	0.10	3.21	Slight Acidity	0.594
8	6.20	0.14	0.25	0.01	0.21	0.04	0.10	0.13	5.89	Slight Acidity	0.528
9	5.62	0.62	1.07	0.05	0.28	0.10	0.55	0.15	4.28	Moderate Acidity	0.825
10	5.77	0.32	0.56	0.03	0.28	0.12	0.30	0.14	1.34	Moderate Acidity	0.561
11	5.78	0.36	0.62	0.03	1.19	0.04	0.05	0.13	0.00	Moderate Acidity	0.495
12	6.77	1.27	2.20	0.10	0.41	0.02	1.20	0.10	44.94	Slight Acidity	0.462
13	6.20	0.26	0.45	0.02	0.23	0.02	0.30	0.11	9.63	Slight Acidity	0.396
14	5.75	0.40	0.70	0.04	0.39	0.04	0.40	0.21	11.77	Moderate Acidity	0.693
15	6.63	0.48	0.83	0.04	1.34	0.04	0.30	0.18	16.59	Slight Acidity	0.561
16	5.25	0.82	1.42	0.07	0.33	0.07	0.65	0.20	21.40	Strong acidity	0.8415

Table 3: Effect of lime on maize yield (t ha^{-1}) at Kwali, FCT, Abuja

Treatment	Grain yield (t ha^{-1})
Absolute control	0.78
0 kg ha^{-1} lime	2.02
250 kg ha^{-1} lime	4.32
500 kg ha^{-1} lime	3.30
Mean	2.60
Significance	0.001***
SE±	0.059
LSD	0.178
CV%	5.3

*** Significance at ($p<0.001$)

partially be linked to the management history from the site. On the whole, P availability may hamper due to nature of the soil reaction and parent materials. Lime requirement is proposed for the site (Table 2) for optimum yield and food security. By and large, satisfactory response may not be achieved with liming alone without the complementary effect of organic or inorganic fertilizer.

Table 3 shows the effect of combined fertilizer and lime on maize yield. Organic amendments are major source of Soil Organic Matter (SOM), which forms a major pool of essential nutrients such as NPK and S as well as essential micronutrients (Sanchez *et al*., 1989). During the decomposition process the activities of the various microorganisms and fauna involved in the process also serve to promote soil aggregation leading to reduced erosion and greater infiltration capacity of the soil. High OM status of the soil also improves the water holding capacity of the soil and its nutrient retention characteristics (Woomer and Swift, 1994).

However, most studies conducted on highly weathered soils (Igbokwe *et al*., 1982; Friesen *et al*., 1982; Okeafor, 1999), reported that liming alone seldom has satisfactory response in Acrisols/Ultisols of the lowland but Humic Acrisols may be an exception. The absolute control (No lime and No fertilizer) on the soils studied yielded 0.78 t ha^{-1} of maize through 3.30 t ha^{-1} of 500 kg ha^{-1} lime. Application of 250 kg ha^{-1} lime proved to be significantly superior 4.32 t ha^{-1} than other treatments (Table 3). Although, treatment T4 (500 kg ha^{-1} lime) seems to be non-economical and the tendency of over liming effect may be experienced. Ogola and Keter (1995) reported non-significant of lime on maize yield although, lime x phosphorus interactions were observed in both first and second harvests. Lime markedly increased the efficiency of applied phosphorus uptake in the soil. According to Friesen *et al*. (1982) liming with 0.5 Mg ha^{-1} powered Ca $(OH)_2$ maintains Cowpeas near maximum yield for 2years; one-time 2Mg ha^{-1} sustained yields for 5years. They proposed critical level of Al^{3+} for corn to be 35%. Busari *et al*. (2004) reported integrated use of lime and 10 t ha^{-1} Poultry Manure (PM) gave a yield of 4.6 t ha^{-1} when compared with a yield of 4.02 t ha^{-1} for 10 t ha^{-1} PM+NPK.

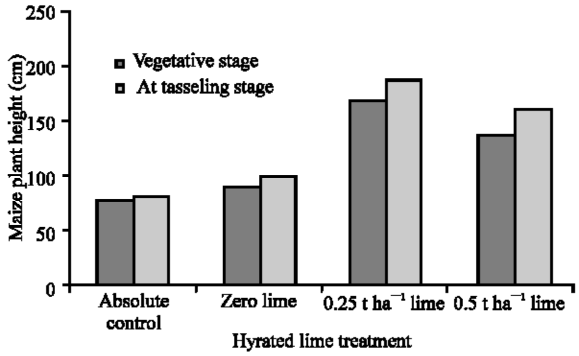

Fig. 1: Effect of hydrated lime on maize plant height at Kwali, FCT, Abuja

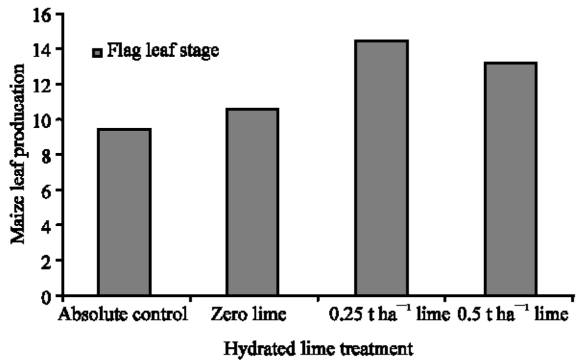

Fig. 2: Effect of hydrated lime on maize leaf production at Kwali, FCT, Abuja

From Fig. 1, the application of 0.25 t ha^{-1} lime increased the uptake of nutrient elements especially phosphorus, therefore, increased the growth and development of maize plant. Although, with increase of the treatments from 0.2-0.5 t ha^{-1} vegetative growth of the maize plant drastically reduced. This interprets the effect of over liming on soil and crop plant which can be translated to decreased uptake of several nutrient elements, especially iron, manganese, zinc and decreased phosphate availability as a result of the formation of relatively insoluble P compounds, such as di- and tricalcium phosphates.

Figure 2 shows the effect of hydrated lime on maize leaf production which is an index of yield component. Leaf production increased linearly from absolute control to application of 0.25 t ha^{-1} lime and diminished. It depicts that production of maize forage for livestock production can be achieved at this optimum level (0.25 t ha^{-1}).

CONCLUSIONS

A factorial experiment was conducted on a NSPFS field at FCT, Abuja to investigate the effect of hydrated lime on the growth of maize. The soils have been classified as Ultisols. The results revealed very low to low fertility related properties with moderately to slightly acidity. Application of 0.25 t ha^{-1} of hydrated lime+0.25 t ha^{-1} of NPK 15-15-15+2 t ha^{-1} of FYM incorporated into top soil increased the growth of maize significantly.

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