LIMING AND NUTRIENT INTERACTIONS IN TWO ULTISOLS FROM SOUTHERN NIGERIA*

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SUMMARY

A short-term pot experiment was conducted to study the effects of liming on nutrient availability to maize plants grown in two acid Ultisols (Ustoxic Paleustult and Oxic Paleudult). Optimum P availability occurred between pH 5 and 6. Liming depressed uptake of Mg, Mn, and Zn by the plants. Maize grown in the Ustoxic Paleustult showed severe Mn deficiency when the soil was limed to near neutrality even though a moderate amount of Mn was applied.

A laboratory incubation experiment showed that liming resulted in sharp decreases in soluble Mg, Mn and Zn in the soil, whereas the soluble K level was only slightly affected.

Inadequate Ca supply appeared to be a more important factor affecting plant growth and nutrient uptake than Al toxicity in the coarse-textured Ultisols.

INTRODUCTION

Research on liming Ultisols and Oxisols in the lowland tropics for food crop cultivation is still in its infancy. Published results often vary widely regarding the effects of liming on nutrient interactions and availability. Inconsistent crop responses to liming and soil pH changes in the tropics further suggest the need for new criteria to predict lime requirement for these highly-weathered and strongly-leached acid soils15 17.

The effect of liming on P availability to plant can vary from detrimental to beneficial14. For instance, liming soil to pH 7 decreased P availability to sorghum grown in an aluminous ferruginous latosol but not in a humic ferruginous latosol in Hawaii8.

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Reeves and Sumner\textsuperscript{18} found that liming did not reduce P fixation on some Oxisols from Natal. Amarasiri and Olsen\textsuperscript{1} reported that liming a Colombian Oxisol to pH 6.5 resulted in a sharp decrease in soil P solubility. Fewer published results deal with the effects of liming on soil K and micronutrient availability. Ayres\textsuperscript{2} reported that the leaching loss of K from two Hawaiian soils was reduced by liming. Fox and Plucknett\textsuperscript{7} showed that liming volcanic ash soils to neutrality induced Zn deficiency in maize.

In West Africa, the widely occurring coarse-textured Ultisols are generally deficient in almost all essential nutrient elements\textsuperscript{12}. A limited number of field trials on liming indicated that crop growth is improved by liming only when N, P, K, Mg, S and organic manure are applied\textsuperscript{6}. Therefore, the critical factor for crop growth in these coarse-textured Ultisols lies in the use of well-balanced nutrient applications in addition to liming to eliminate Al toxicity. This paper examines the effects of liming on nutrient availability to plants and on the distribution of nutrient ions in the soluble and exchangeable phases using two acid Ultisols from southern Nigeria.

\textbf{MATERIALS AND METHODS}

\textit{Soil samples}

Surface soil (0–15 cm) samples of Nkpologu sandy loam and Alagba sandy loam were collected at the Experimental Farm of the University of Nigeria at Nsukka and the Nigerian Institute for Oil Palm Research of Benin, respectively. The Nkpologu soil was derived from Cretaceous sandstone and the Alagba soil from coastal sediments of Tertiary age. Some chemical and physical properties are given in Table 1. The clay fraction of both soils contains predominantly kaolinite with small amounts of goethite and hematite. The Nkpologu soil also contains a moderate amount of gibbsite\textsuperscript{9}.

\textit{Soil chemical analysis}

Organic C was determined by dichromate oxidation. Exchangeable bases by neutral N\textsubscript{H}4OAc displacement and exchangeable Al and H by KCl extraction and easily reducible Mn by shaking the soil for one hour with N\textsubscript{H}4OAc containing 0.2\% hydroquinone\textsuperscript{9}. Contents of Ca, K and Na in the extracts were determined on an EEL flame photometer and Mg, Mn and Zn on a Perkin-Elmer Model 403 atomic absorption spectrophotometer. Total acidity (\textit{Al} + \textit{H}) in the KCl extracts was determined by titration and Al by the colorimetric procedure using aluminon\textsuperscript{11}. Point of zero charge (PZC) was determined by potentiometric titration as described by van Raij and