Maize response to phosphate and lime on marginal fertility soils of Western Kenya

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Introduction

Maize (*Zea mays* L) is the most important food crop in Kenya, contributing 20% of the total agricultural production and 25% of agricultural employment (Ayaga, 2003). However, maize yields are declining in the country whereby the levels below 0.5 t/ha/season are common on smallholder farms in the populous western Kenya (Nekesa et al., 1999). This is indeed a food insecurity situation. The falling maize yields are largely explained in terms of cropping low quality seeds, soil fertility depletion and poor agronomic practices. In relation to soils, the limitation of phosphorus (P) on agricultural productivity in the highly weathered and leached acid soils is well documented. In these soils, P sorption by Fe and Al elements largely accounts for low recoveries of about 15% of applied P fertilizer, thereby contributing to reduced P availability, uptake and low crop yields. Moreover, as a result of unaffordable fertilizer prices, nutrient inputs are rarely added to soils. Nonetheless, most farmers in Kenya plant a wide cross-section of improved maize seed, targeting high yields. Information regarding seed-site specificity is rather on the formative stages. To this end, maize breeding towards tolerance to P and Al stresses is likely to offer an opportunity to identify and recommend high yielding and acceptable cultivars. Thus in a collaborative effort, from 2003 researchers from Embrapa Maize and Sorghum (Brazil), Purdue and Cornell Universities (USA) and Moi University (Kenya) characterized soils from maize growing areas in Kenya and studied the performance of five major genotypes (tolerant and susceptible to acid stress) at two smallholder farms, Kuinet and Bumala, in Western Kenya. Traits of performance were plant vigor, height and yield differences, N and P uptake and their use efficiencies.

Methodology

Kuinet and Bumala sites have acid soils (pH<5.0), low available phosphorus (<5mgP/kg) and rather high Al saturation (>27%) (Obura et al., 2003). Two of the major genotypes evaluated were the CIMMYT's (Mexico) acid stress and to tolerant to acidity susceptible, while the other two were the Kenyan (KARI's) landraces, tolerant and susceptible to soil acidity stress.

The fifth genotype was the populous Kenyan highland hybrid H 614D, moderately tolerant to soil acidity. All five major genotypes were compared in 2003 without and with application of 75kg N/ha + 26kg P/ha (KARI's recommendation), together with the intervention of 4 t/ha agricultural lime, to ameliorate soil acidity. Later trials in 2004 and 2005 sought to identify economical levels of nutrient inputs over a range of rates (0-75kg N/ha + 0-120 kg P/ha + 0-6 t/ha lime) applied to Striga weed tolerant maize hybrid (IR – imazyphyr chemical coated seed).

Results and Discussion

Both P and lime stimulated root growth and maize yield (range 0.33 to 4.73 t/ha in the year 2003). Acid tolerant cultivars (Cimcali 97 BA Chap. 7 ASA and 2AI – Vihiga, Kenya) were associated with higher physiological as internal P use efficiency (113 to 195 kg grain/kg P uptake) from P applied at 26kg P/ha. However, all 3 Kenyan maize genotypes outyielded the CIMMYT's genotypes. Thus genotypic variability adaptation to acid soils and soil fertility management can be explored to achieve high yields at low nutrient input costs. Maize yields up to 6.0 t/ha have been obtained across 3 sites (including the additional Sega site in Siaya district, Kenya). Maize performance varies with sites, but with significant (P=0.05) effect of P showing in all sites, whereby the combined P and lime additions favors maize yield increases and overall positive economic returns.

Conclusions

- There is potential to breed maize cultivars tolerant to acid stresses in the low fertility soils in an area covering about 0.5 million hectares of continuously cultivated croplands in western Kenya.
- Economical levels of nutrient inputs appear to be 75kgN/ha, together with 20kg P/ha and 2 +/ha lime; these may be adopted in future maize breeding programmes towards Al tolerance and P use efficiency.
- Lime raises the pH of soils and favors P availability in soils.

References

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