A STUDY OF THE EFFECT OF PHOSPHATE FERTILIZERS ON MAIZE AND SORGHUM PRODUCTION IN SOME EAST AFRICAN SOILS

By

John Robert Okalebo

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SUMMARY

Laboratory, pot and field experiments were carried out from 1975 to 1982 to study the responses of maize (Zea mays L.) and sorghum (bicolor L. Moench) to phosphate fertilizer applications in 19 sites in Kenya and Uganda. The locations varied widely in altitude, climate and soil properties.

The surface soils (0 to 20 cm depth) sampled from the high altitude and cooler areas, namely, Muguga and Kakamega (Nitisols), and Kitale (Ferralsols) gave higher levels of total nitrogen, organic carbon and clay, compared with soils from Machakos and Kitui areas (predominantly Luvisols). These latter areas are semi-arid and are of lower altitude and warmer climate.

Total phosphorus in 19 surface soils ranged from 37 to 1213 ppm P; organic phosphorus was from 6 to 452 ppm P and accounted for about 69% of total P in all the 19 soils. Variations in P status seemed to be related to the soil parent materials in that soils derived from the undifferentiated metamorphic rocks contained higher levels of total and available P. Phosphate sorption by surface soils was highest in nitisols, which had a high clay content and lowest in luvisols.

Pot tests, using rhodes grass (Chloris gayana) as a test crop, showed widespread phosphorus deficiency. Thus, phosphate applied at 60 kg P/ha significantly increased the dry matter yields and uptake of P by grass in almost all soils used for tests. Grass cropping in pots for 19 weeks resulted in a faster decline in yields in soils taken from semi-arid locations, compared with soils from high altitude areas. Responses to P were obtained in soils where relative percentage yields mainly of grass were below 80% . Cummulative yields of grass on control treatment from three consecutive harvests were negatively and not significantly correlated with the procedures used to estimate available P in 15 soils used for pot tests. But in the 8 soils with higher organic matter content (taken from high altitude and cooler locations), cummulative yields of

grass were significantly related to Egner - Riehm (ammonium lactate + acetic acid; r = 0.90), Mehlich (0.1 N HCl + 0.025 N H_2SO_4; r = 0.84), Truog (0.002 N H_2SO_4; r = 0.73) and Olsen (0.5 M $NaHCO_3$; r = 0.69) levels of available P. However, cummulative yields of grass from 7 soils with lower organic matter content were not significantly correlated with available P levels using Egner - Riehm (r = - 0.51), Mehlich (r = - 0.50), Truog (r = - 0.41) and Olsen (r = - 0.42) methods of P extraction.

In all field trials, the growth of maize and sorghum was favoured by the side band application of 70 kg N/ha plus 80 kg P/ha (placed 7 cm to the side and 10 cm below the seed, or in soil ridges) at planting time. But patchy seedling emergence occurred when N and P were applied (in side bands) above these two rates.

Combined N and P fertilizer applications, from 30 to 106 kg N/ha and from 13 to 120 kg P/ha, significantly increased the dry matter and phosphorus uptake of maize and sorghum tops during the vegetative stage of growth in nearly all locations. In addition, yields of maize grain and stover and sorghum grain and stalk, were increased by N and P applications; but the increases varied depending on the length of the growing season and hence the cultivars used. Thus, in the high altitude and high rainfall locations, 39 kg P/ha plus 60 kg N/ha gave significant maize grain yield increases (above control treatments) reaching 4162 kg/ha (at Kitale Research Station 1975); whereas 40 kg P/ha plus 60 kg N/ha produced a grain yield increase of 1360 kg/ha (at Ithookwe Sub-station 1981) in the low altitude and marginal rainfall areas. With regard to sorghum, 40 kg P/ha plus 106 kg N/ha gave a significant grain yield increase of 2533 kg/ha in the high rainfall Serere Research Station in 1976; while 40 kg P/ha plus 60 kg N/ha gave a grain yield increase of 1692 kg/ha at Ithookwe Sub-station.

Marginal analysis on maize grain yield data of 1977 showed that a farmer obtained cash profits from diammonium phosphate or triple-superphosphate applications at 20 kg P/ha plus 100 kg N/ha. But net returns decreased with subsequent P increments. Hence higher P rates would be useful in soils where residual P effects are important (such as the nitisols). However, in view of wide variations in N and P fertilizer recommendations in East Africa, further studies are suggested to investigate the residual value of P and to establish economic levels in different ecological zones within the region.

Maize and sorghum grain yields were significantly correlated with yields of tops obtained at the vegetative stage of growth, particularly in locations with large P responses. Grain yields were also significantly associated with organic matter (total N and organic C) contents of soils, but not significantly correlated with available P extracted in soils using 8 procedures. Rainfall and its distribution and inherent soil fertility probably influenced the correlations. Thus, the correlation coefficients between grain yields of maize and Olsen P levels in soils were improved when data from locations with low rainfall and high soil P status were eliminated in correlation analysis.