Similarities and differences in the chemistry and mineralogy of some acid soils from maize growing regions of Kenya, Uganda, Tanzania, and Brazil

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Food insecurity remains a persistent problem in much of sub-Saharan Africa. The causes are complex, but low soil fertility and lack of high-yielding germplasm are important aspects of the problem. As part of a larger project that has the goal of enhancing phosphorus acquisition and aluminum tolerance of plants grown in marginal soils (McKnight Foundation, 2010), Al-tolerant and P-efficient germplasm developed in the Cerrado Region of Central Brazil was introduced into a maize breeding program in the highlands of East Africa where soil acidity and low fertility remain a persist constraint to crop production. Transfer of germplasm from one area to another is likely to be most successful when the soils are similar in both areas and when the soil constraints are fully understood. Accordingly, we compared the chemistry and mineralogy of acid soils from the maize growing regions the Cerrado Region of central Brazil with soils from maize growing regions in Kenya, Uganda, and Tanzania where the Brazilian germplasm is to be introduced.

We sampled 19 soil profiles representative of major maize growing regions of East Africa, 11 from Kenya, 4 from Uganda, and 4 from Tanzania (Fig. 1). Eight soils from the Cerrado Region of Central Brazil were selected from samples previously described by Marques et al. (2004a, b). Analyses included pH, cation exchange capacity, extractable Al, P sorption capacity, P released by low molecular weight organic acids, x-ray diffraction analysis of the <2 µm clay fraction, and scanning and transmission electron microscopy.

All of the soils were acid, with pH(H_2O) varying from 4.3 to 6.5. Aluminum saturation ranged from 0% for soils with the highest pH, to >60% for some of the Brazilian soils and for 3 of the Kenyan soils. The Kenyan soils fall into two groups. The 8 soils west of the Rift Valley are similar to the Brazilian Cerrado soils in terms of P-sorption, with a maximum P sorption of ~1,000 mg kg^{-1}. The 3 soils east of the Rift Valley formed from porous volcanic ash parent materials and had maximum P sorption capacities that were about 3 times higher (~3,000 mg kg^{-1}) due to higher amounts of halloysite and gibbsite. The 4 soils from eastern Uganda had negligible Al saturation and P sorption capacities ≤300 mg kg^{-1}, and thus should thus present fewer problems with Al toxicity and P sorption than the Kenyan soils. Three of the 4 soils from Tanzania had pHs ~ 6.0 and negligible Al saturation. One-to-one clay minerals (kaolinite and/or halloysite) were the most abundant minerals in the clay fraction of all of the soils, but gibbsite was common in many of the Brazilian soils and in the 3 soils from Kenya east of the Rift Valley.

In general, soils in the maize growing regions of Kenya west of the Rift Valley are quite similar in terms of Al toxicity and P sorption to soils in the Cerrado Region of Central Brazil. Thus germplasm from Brazil should encounter a similar soil environment in western Kenya. The soils sampled in eastern Uganda and in Tanzania should provide an even less severe soil environment. The high Al saturation and P sorption capacity of the soils east of the Rift Valley in Kenya present the most severe constraint to maize production.

References

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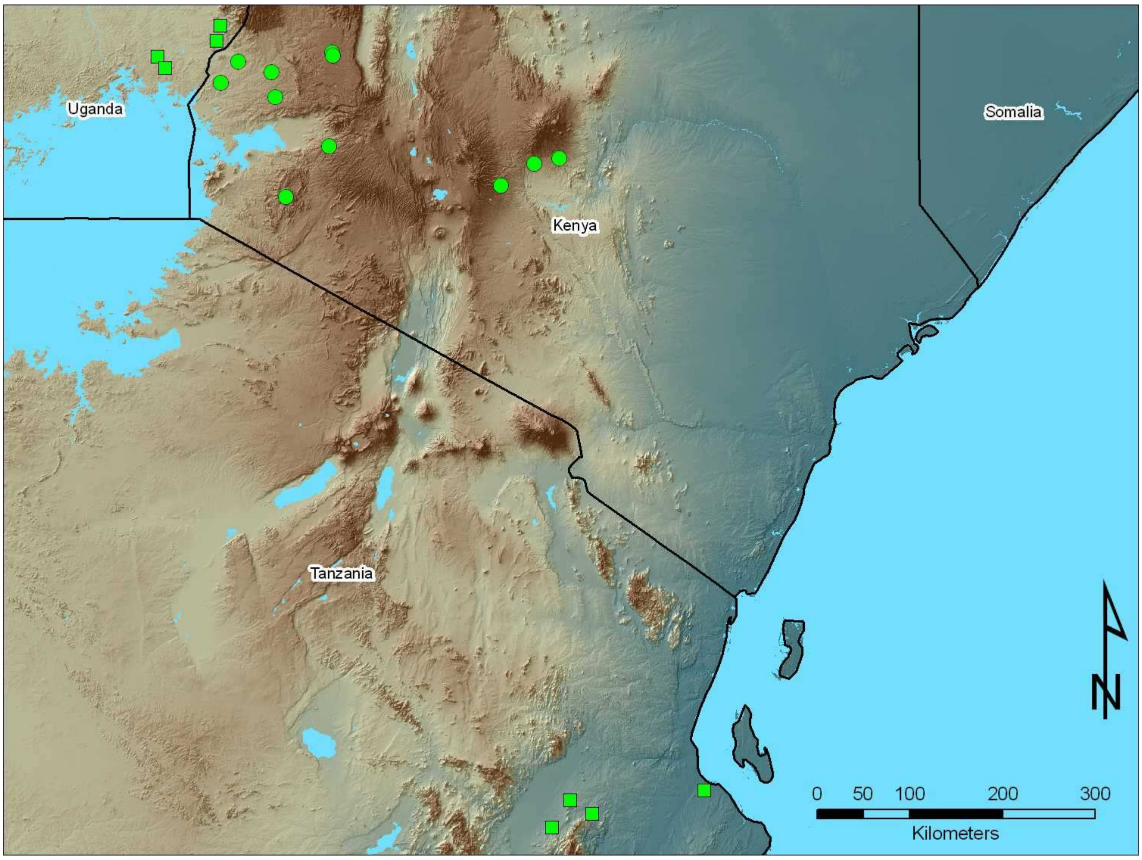

Fig. 1. Location of the sampling sites in maize growing areas of Kenya, Uganda, and Tanzania.