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Research Application Summary

# Effects of lime and phosphorus fertilizer on maize performance in acid soils of western Kenya

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## Abstract

Western Kenya continues to experience food insecurity due to increasing soil acidity and consequent phosphorus deficiencies with 0.9 million hectares of land having pH < 5.5. Liming is one of the interventions recommended to ameliorate such soils. Field trials were conducted in Siaya and North Kakamega districts to evaluate and compare direct and residual effects of agricultural lime and Mavuno fertilizers on soil properties and maize performance. Lime was obtained from two Kenyan sources, Homa Hills and Athi River mining companies and Tanzania (Minjingu Phosphate Rock). Preliminary results show that the highest plant height was obtained from Mavuno fertilizer followed closely by agricultural lime from Homa Hills. There is need to determine the properties of the lime from the different sources in order to recommend that with highest potential of improving maize yield in the region.

Key words: Acidic lime, maize, Minjingu Phosphate Rock, soils, western Kenya

## Résumé

Le Kenya occidental continue à vivre l'insécurité alimentaire due à l'acidité croissante du sol et aux insuffisances conséquentes de phosphore avec 0.9 million d'hectares de terre ayant un pH < 5.5. L'application de la chaux est l'une des interventions recommandées pour améliorer de tels sols. Des essais pratiques ont été conduits dans les districts de Siaya et du nord de Kakamega pour évaluer et comparer des effets directs et résiduels sur les propriétés du sol et la performance du maïs due à l'usage de l'engrais calcique et des engrais de Mavuno. La chaux a été obtenue à partir de deux sources Kenyanes à savoir les collines de Homa et les compagnies d'exploitation minières du fleuve d'Athi et aussi à partir de la Tanzanie (phosphate naturel de Minjingu). Les résultats préliminaires prouvent que la taille la plus élevée des plantes a été obtenue à partir de l'engrais de Mavuno suivi de près par l'engrais calcique des collines de Homa. Il y a le besoin de déterminer les propriétés de la chaux des différentes sources

afin de recommander son usage pour un potentiel le plus élevé d'amélioration du rendement de maïs dans la région.

Mots clés: Chaux acide, maïs, phosphate naturel de Minjingu, sols, Kenya occidental

## Background

The sub- Saharan Africa region, Kenya included, continues to experience food insecurity due to soil acidity and nutrient depletion all of which contribute to the widespread poverty in the region. In western Kenya, about 0.9 million hectares of land are acidic with pH < 5.5 causing high phosphorus deficiencies. As a result, production levels of maize and legumes are markedly low. For example, Sanchez *et al.* (1997) and Nekesa *et al.* (1999) reported crop yields below 1 t $ha^{-1}$ from smallholder farms. These yields are very low as compared to the 6-8 t $ha^{-1}$ $year^{-1}$ that have been reported in research stations and/or field experiments with adequate management (Okalebo *et al.,* 2005).

Lime materials applied as calcium hydroxide $Ca(OH)_2$, calcium oxide (CaO) or calcium carbonate ($CaCO_3$) have been found to effectively neutralize soil acidity by raising the pH of acidic soils, providing $Ca^{2+}$ and decreasing aluminium (Al) toxicity hence stimulating crop growth (Adams, 1984; Kanyanjua *et al*., 2002). Rock Phosphate (PR) has also been found to neutralize soil acidity (Kanyanjua *et al.,* 2002; Nekesa, 2007). However, while many end users of phosphate rock (PRs) recognize their phosphate benefits, they do not recognise the liming effect and little is known about these practices in this region.

Therefore, this study involved physico – chemical characterization of North Kakamega and Siaya districts soils, determining the effect of Minjingu Phosphate rock, Mavuno fertilizer and agricultural lime from Athi River and Koru on soils in the mentioned districts. The study also is determining the effect of Minjingu phosphate rock (MPR), Mavuno fertilizer and agricultural lime from Koru and Athi River on maize yields and economics of using MPR, Mavuno fertilizer and agricultural lime from Koru and Athi River on maize production in the two districts.

## Literature Summary

Several approaches have been used to manage soil acidity. These include use of soil amendments that counteract the effects of soil acidity or using crops that are tolerant to high level of exchangeable Al (Biswas and Mukherjee, 1994). Young (1989)

also reported the use of mulch from agroforestry tree species, burning of sites to produce ash and use of animal wastes such as poultry manure. However, in most cases these materials are too bulky, variable in quality (Probert *et al*., 1992; Woomer *et al*., 1999) and are always not available in adequate amounts required. Agricultural lime, PRs and fertilizers that contains Ca and Mg have a liming potential which have not been tapped. There is thus need to demonstrate the usefulness of these materials to farmers (Okalebo, 2009; Sanginga and Woomer, 2009).

Research results show that one time large application of PR had positive residual effects on crop yields during several consecutive cropping seasons, which justified the use of PR to improve the soil's P status and reduce acidity (Mokwunye, 1995; Buresh *et al.*, 1997). Noordin (2002) reported positive effects of up to 10 cropping seasons from MPR whereas Ndungu *et al.* (2006) reported residual effects of upto three years from modest rate of 60 kg P $ha^{-1}$ as MPR applied to a Ferralsols in western Kenya. On the other hand, Nekesa (2007) reported that MPR increased soil pH to values greater than 5.5 which was maintained for two consecutive cropping seasons.

**Study Description**

An on-farm experiment is on on-going in the mentioned study sites. The experiment will be carried out for two seasons of the 2010 Long Rains (LRs) season, between March and August and short rains (SRs) between September and December. Siaya district lies between latitude 0° 30' N and latitude 34° 30' E. The altitude varies from 1,140 to 1,400 m above sea level. North Kakamega district is located between longitudes 34° 52' and 15°E and latitudes 00° 26' and 00° 52' N. It rises between altitudes of 1300 to 1900 m above sera level.

Soil samples were taken from depth 0 – 15 cm for characterization. The soils were analyzed for soil pH, particle size, soil available P (Olsen P), exchangeable bases, exchangeable acidity, organic carbon and total Nitrogen.The soil samples will be collected again as described above at different time intervals during the growing period, so as to monitor changes in pH and available P. At all the locations, the experimental design is a factorial arranged in a split block.

**Research Application**

Application of Mavuno fertilizer has resulted in the highest plant height, followed closely by Koru lime (Table 1). The preliminary results suggest that application of lime and P fertilizer materials should be encouraged.

**Table 1. Mean plant heights (cm) in two districts of western Kenya.**

| Treatment | 38 DAS | 50 DAS | 70 DAS |
|---|---|---|---|
| **Siaya district** | | | |
| Control | 95 | 159 | 212 |
| Athi lime | 110 | 191 | 227 |
| Koru lime | 106 | 126 | 220 |
| Mavuno | 124 | 210 | 228 |
| MPR | 87 | 162 | 202 |
| **North Kakamega district** | | | |
| Control | 73 | 109 | 172 |
| Athi lime | 81 | 129 | 209 |
| Koru lime | 91 | 137 | 220 |
| Mavuno | 79 | 128 | 203 |
| MPR | 73 | 109 | 172 |

DAS = Days after planting.

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## References

Adams, F. 1984. Crop response to lime in the southern United States. In: Adams, F. (Ed.) Soil acidity and liming. 2nd ed. Agron. Monogr. 12. ASA. CSSA. and SSSA. Madison. WI. pp. 211-265.

Kanyanjua, S.M., Ireri, L., Wambua, S. and Nandwa, S.M. 2002. KARI Technical Note No. 11. Acidic soils in Kenya: constraints and remedial options. KARI Headquarters, Nairobi, Kenya.

Nekesa, A.O. 2007. Effect of Minjingu phosphate rock and agricultural lime in relation to maize groundnut and soybean yields on acid soils of western Kenya. M- Phil Thesis, Moi University, Eldoret, Kenya.

Nekesa, P.O., Maritim, H. K., Okalebo, J.R. and Woomer, P. L. 1999. Economic analysis of maize bean production using a soil fertility replenishment product (PREP-PAC) in Western Kenya. *African Crop Science Journal* 7:157-163.

Okalebo, J.R. 2009. Recognising the constraint of soil fertility depletion and technologies to reverse it in Kenyan agriculture. Moi University inaugural lecture 6 series no. 1. Moi University Press, Eldoret, Kenya.

Sanchez, P.A., Shepherd, K.D., Soule, M.J., Place, F.M., Buresh, R.J., Izac, A. M., Mukwenye, A. V., Kwesiga, G. R., Ndiritu, C.G. and Woomer, P.L. 1997. Soil fertility replenishment in

Africa: An investment in natural resource capital. In: Replenishing soil fertility in Africa. *Soil Science Society of America Journal Special Publication* 51:293-310.

Woomer, P.L., Okalebo, J.R. and Sanchez, P.A. 1997. Phosphorus replenishment in western Kenya: From field experiments to an operational strategy. *African Crop Science Conference Proceedings* 3(1):559-570.