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Effects of Soil and Foliar Applications of Zinc on Grain Zinc Concentrations of Maize, Sorghum and Wheat in Zambia

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INTRODUCTION

Micronutrient deficiencies are quite widespread in Sub-Saharan Africa including Zambia. A survey study of selenium and zinc content in selected soils and staple food crops showed low concentrations that suggested that populations might be at risk of low intake of these micronutrients through the diet. The beneficial effects of Se and Zn are well documented in human populations (Black et al. 2008). Agronomic bio-fortification offers a promising strategy to address micronutrient deficiency in the diet (Cakmak, 2008). This study was conducted to evaluate the effects of soil and foliar applications of Zn on Zn concentrations in maize, sorghum and wheat.

METHODS

Field trials were conducted in which zinc was applied through three methods: a) no soil and no foliar Zn applied (i.e. Control treatment), b) soil application of 50 kg $ZnSO_4.7H_2O$/ha at planting and c) soil and foliar application of Zn which involved soil application of 50 kg $ZnSO_4.7H_2O$/ha as in b) and applications of 0.5 % $ZnSO_4.7H_2O$/ha (equivalent to 4 kg $ZnSO_4.7H_2O$/ha) as a foliar spray. These treatments were replicated four times and arranged in a Randomized Complete Block Design at each of three locations in the country.

RESULTS AND DISCUSSION

The results showed that the combination of soil and foliar Zn application was effective in increasing grain Zn concentration of maize (Table 1). The Zn content of the soils at the site was adequate (>0.50mg kg^{-1} of DTPA- extractable Zn) and, therefore, a response to application of Zn fertilizer. Preliminary data show that sorghum responded similarly to these treatments with zinc on the same soil. In contrast to maize and sorghum, foliar application of Zn was highly effective in increasing grain Zn concentration of wheat (Table 2). The greatest increase in grain Zn concentration was obtained from a combination of soil Zn and foliar application. Superimposition of NPK fertilization appear to have had little effect on Zn uptake from soil and foliar spray.

Table 1. Effect of soil and foliar Zn applications on grain Zn concentration of maize at three locations

Treatment	Grain Zn Concentration (mg kg^{-1})		
	Magoye	Batoka	Chisamba
Control (No Zn)	19.0	17.8	20.5
Soil Zn	22.5	21.8	21.8
Soil Zn + Foliar Zn	25.3	24.0	19.8
LSD (0.05)	4.2	3.0	3.5

Table 2. Effect of soil and foliar application of zinc on grain zinc concentration of wheat

Treatment	Grain Zn, mg kg^{-1}
Control	23.5 ± 2.1
NPK + Urea	20.8 ±2.2
Soil Zn	23.8 ± 1.1
NPK + Urea + Soil Zn	24.2 ± 3.2
Soil Zn + 2X Foliar Zn	43.0 ± 5.6
NPK+ Urea + Soil Zn +2X Foliar Zn	46.4 ± 4.7

CONCLUSIONS

The results obtained showed foliar application of Zn were highly effective in increasing the concentration of Zn in cereal grains. The effect of foliar Zn application was greater on wheat than maize and sorghum. The reason for this differential effect on foliar Zn spray on grain Zn of these 3 cereal crops is not well understood, and might be related to their grain protein levels (Kutman et al., 2011). As discussed by Kutman et al. (2011) high protein in grain represents an important sink for Zn.

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