Evaluation of POLY4 (polyhalite) fertilizer on corn grain yield in selected agro-ecological zones of Tanzania

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Abstract

Polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$, POLY4®) is a new fertilizer in Tanzania and needs to be assessed for its effectiveness prior to recommending for use to farmers. Two nutrient rate response experiments were conducted under rainfed conditions to assess the effectiveness of POLY4 fertilizer on corn (*Zea mays* L.), one was in central highlands at district Kilindi and the second trial was in coastal plateau at Bagamayo district. POLY4 and Muriate of Potash (MOP) were evaluated at 12, 24 and 48 kg ha^{-1} rates of K_2O. Yield and yield attributes were measured and ear leaf samples were analysed for various nutrients as per the standard procedures. All treatments including N+P control were supplied with equal amounts of N and P_2O_5 fertilizer. Control which was not supplied with any K_2O resulted in 2143 and 2813 kg ha^{-1} of grain yield at Kilindi and Bagamayo districts, respectively. POLY4 recorded 31 and 37% significantly higher grain yield than Control and recorded 9 and 14 % higher yields than MOP at Kilindi and Bagamayo districts, respectively. Potassium fertilization resulted in significantly higher plant height at Kilindi and greater plant stand and plant height in the Bagamayo district. Results indicate that POLY4 fertilizer could be used as a source of potassium in eastern agro-ecological zones of Tanzania.

Introduction

Studies conducted in the East African region including Tanzania show that most villages where the bulk of agriculture takes place comprise resource poor farmers (80%) who basically depend on a corn-beans subsistence farming methods to make ends meet. Crop yields in these villages are very low owing to use of inadequate agronomic practices. Increased populations, inadequate knowledge on judicious fertilizer use and now increased access to the cash economy has left most of these farmers cultivating whatever piece of land they can lay their hands on. In doing so, a significant number of agricultural lands have now been degraded and its productivity has significantly declined. The impact of all this reflects on the falling household productivity from agricultural enterprises and the rising levels of land use related conflicts.

If farmers can be provided with economical but effective alternatives to the expensive fertilizers, their effective contribution to the national economy will be enormous. Similarly their households will remain food secure while their incomes will improve.

Recent efforts for alternate potassium sources led to the exploration of polyhalite in North Yorkshire in the United Kingdom and New Mexico in the USA . This could ultimately lead to decreased reliance on MOP as a potassium source. Lower cost could be an advantage for POLY4 (polyhalite), owing to its lower processing losses than for SOP or MOP. Hence there is a need to evaluate the agronomic performance of POLY4 in support of the above mentioned contentions. Such evidence is essential for the African region due to the cost of resources and under application of crop nutrients.

Objectives

The specific objectives of the current study is to evaluate POLY4 as a multi nutrient fertilizer for corn in eastern agro-ecological zones of Tanzania.

Methods

Trial locations were located in the north east of Tanzania (Figure 1) to reflect different agro-ecological zones with different soil types (Table 1).

Table 1 – Summary of soil analysis at each trial site

Variable/Location	pH	Organic Matter (%)	N (%)	P (mg/kg)	K (mg/kg)	Mg (mg/kg)	Ca (mg/kg)	EC (mS/cm)
Kilindi	5.9	0.94	0.12	1.78	266	340	1422	0.11
Bagamoyo	6.0	1.37	0.13	1.97	62	138	304	0.12

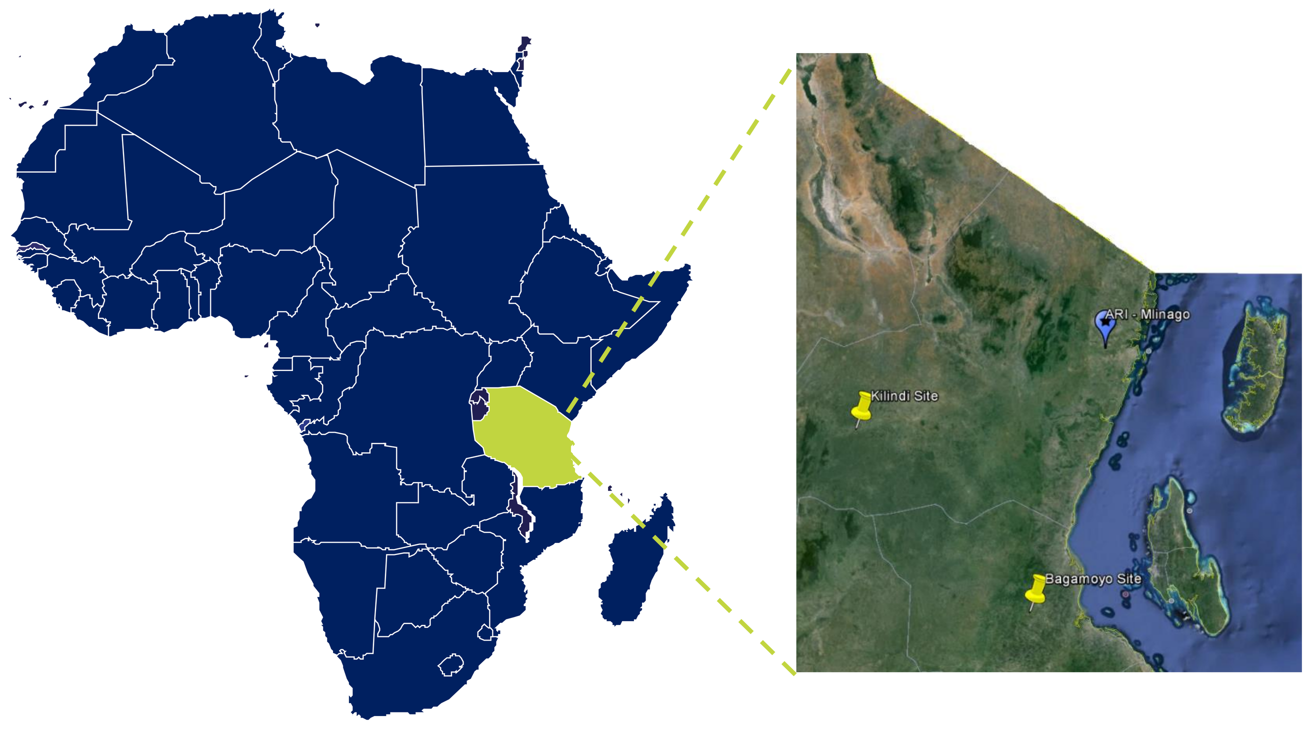

Figure 1 – Trial locations in north east Tanzania

Kilindi is located in the Central Highlands of Tanga region between 200 – 750 mean above sea level. Soils are developed on metamorphic rock supporting a low soil fertility with a moderate to high water holiday capacity. Bagamoyo is located in the eastern coastal region with ferralic Cambisols.

Treatments

MOP and POLY4 were applied at different rates based on their K_2O contents at 12, 24 and 48 kg ha^{-1} rates of K_2O. NP control was not supplied with any Potassium fertilizer. At Kilindi, 60 kg of N and 39 kg of P_2O_5 and at Bagamayo 45 kg N ha^{-1} and 23 kg P_2O_5 ha^{-1} were applied from Urea and DAP

Experiment design

Experimental design at each site is a randomised block design with four replications. Each experimental plot was 5 m x 3 m. Spacing between rows was 75 cm and between plants is 30 cm. Genotype STUKA-M1 was sown at 125 kg ha^{-1}. Locations were maintained in accordance with local husbandry practices under rainfed conditions. Fertilizers were broadcast by hand prior to being incorporated with a cultivator.

Statistical analysis

Statistical analysis was carried out using GenStat software version 17 (VSN International, 2011) using ANOVA with Fisher's least significant difference testing.

Results

Table 2 – Summary of ANOVA p values for the measure variables at Kilindi

Variable	Control	Control * Type	Control * Rate	Control * Type * Rate
Grain yield (kg ha^{-1})	0.1	ns	ns	ns
Biomass (kg ha^{-1})	ns	ns	ns	ns
No of Plants per hectare	ns	ns	ns	ns
Plant Height (cm)	0.059	ns	ns	ns
Stem diameter (cm)	ns	ns	ns	ns
Ear leaf N (%)	0.082	ns	ns	ns
Ear leaf P (%)	ns	ns	ns	0.019
Ear leaf K (%)	ns	ns	ns	ns
Ear leaf Ca (%)	ns	ns	ns	ns
Ear leaf Mg (%)	ns	ns	ns	ns
Ear leaf Cu (%)	ns	0.006	ns	ns
Ear leaf Zn (%)	ns	0.061	0.037	0.078
Plant N (%)	ns	ns	ns	ns
Plant P (%)	0.013	ns	ns	ns
Plant K (%)	ns	ns	ns	ns
Plant Ca (%)	0.028	ns	ns	ns
Plant Mg (%)	ns	ns	ns	ns
Plant Cu (%)	ns	ns	ns	ns
Plant Zn (%)	ns	ns	ns	0.002

Table 3 – Summary of ANOVA p values for the measure variables at Bagamoyo

Variable	Control	Control * Type	Control * Rate	Control * Type * Rate
Grain yield (kg ha^{-1})	0.026	ns	ns	ns
Biomass (kg ha^{-1})	0.149	ns	ns	ns
No of Plants per hectare	0.011	ns	ns	ns
Plant Height (cm)	0.017	ns	ns	ns
Stem diameter (cm)	0.105	ns	ns	ns
Ear leaf N (%)	ns	0.084	ns	ns
Ear leaf P (%)	ns	ns	ns	ns
Ear leaf K (%)	ns	ns	ns	ns
Ear leaf Ca (%)	0.017	ns	0.074	0.502
Ear leaf Mg (%)	ns	ns	ns	ns
Ear leaf Cu (%)	ns	ns	ns	ns
Ear leaf Zn (%)	0.011	0.036	ns	ns
Plant N (%)	ns	ns	ns	ns
Plant P (%)	ns	ns	ns	ns
Plant K (%)	ns	ns	ns	ns
Plant Ca (%)	ns	ns	ns	ns
Plant Mg (%)	0.075	ns	ns	ns
Plant Cu (%)	ns	ns	ns	ns
Plant Zn (%)	0.044	ns	ns	ns

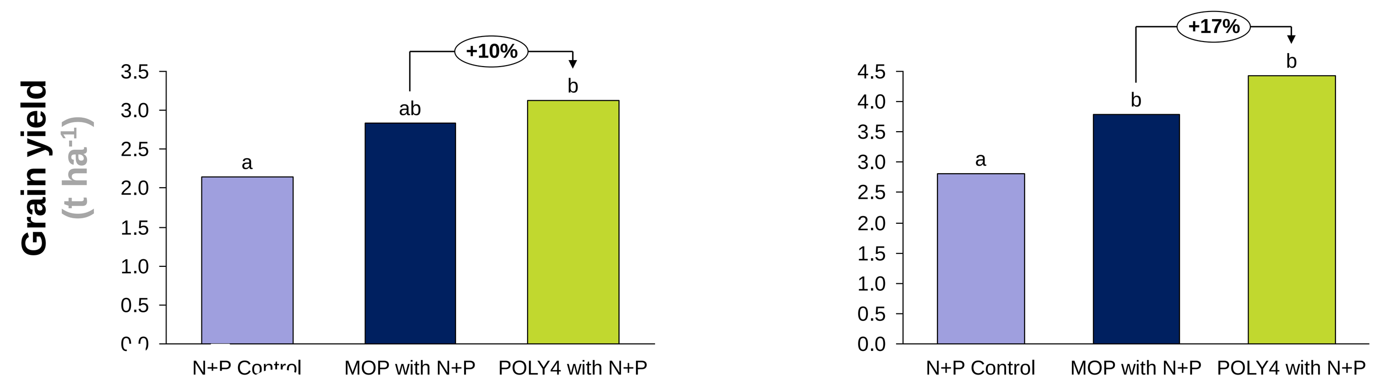

Figure 2 – Corn grain yield at both sites

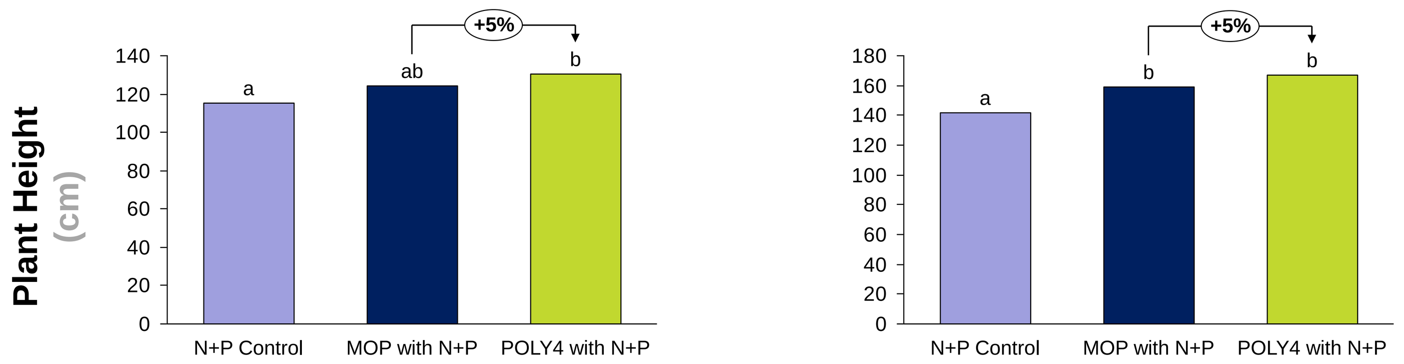

Figure 3 – Plant height at both sites

Control

MOP – 48 K_2O ha^{-1}

POLY4 – 48 K_2O ha^{-1}

Figure 4 – Corn appearance for plots at Kilindi site

Table 5 – Leaf nutrient content for both sites

Variable/Nutrient	Kilindi					Bagamoyo				
	N (%)	P (%)	K (%)	Ca (%)	Mg(%)	N (%)	P (%)	K (%)	Ca (%)	Mg(%)
Control	2.57	0.14	7.10	0.47	0.37	2.27	0.08	9.33	0.31	0.24
MOP	2.46	0.11	7.09	0.33	0.38	2.32	0.07	9.84	0.19	0.28
POLY4	2.45	0.11	6.96	0.39	0.38	2.06	0.08	9.01	0.21	0.30

Conclusions

- Application of potassium irrespective of source enhanced corn grain yield in Central highlands and Eastern coast of Tanzania
- POLY4 recorded 46% and 57% significantly higher grain yield than control at Kilindi and Bagamayo districts, respectively
- POLY4 recorded 13% and 18% significantly taller plants than control at Kilindi and Bagamayo districts, respectively

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