EVALUATION OF POLYHALITE (POLY4) IN COMPARISON TO MURIATE OF POTASH FOR CORN GRAIN YIELD IN TANZANIA

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INTRODUCTION

- A search for alternate potassium sources led to the exploration of polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$) in North Yorkshire in the United Kingdom (POLY4).
- There is a need for more evidence on the agronomic performance of POLY4 and its understanding is essential for the Southern Highlands region of Africa due to the cost of resources and under-applied nutrient conditions in this area. This could ultimately lead to decreased reliance on MOP as a potassium source.
- The Southern Highlands is an agriculturally important area growing a range of crops such corn, beans, wheat and potatoes. The majority of the soils from Tanzania's humid and sub-humid regions were categorised as severely weathered, acidic, infertile and had limited but variable nutrient releasing capacities to sustain low-input agriculture.
- Current fertilizer recommendations to offset nutrient deficiencies in most parts of the region for corn are 80–120 kg N ha^{-1} in two splits; and 23–68 kg P_2O_5 ha^{-1} as basal application. However, critical nutrient deficiencies of N, P, K, S and Ca have increased in the Southern Highlands, such that multi-nutrient fertilizers are increasingly important to supply balanced nutrition to crops to attain high yield and quality of the produce.

OBJECTIVES

- To evaluate POLY4 as a multi-nutrient fertilizer for corn under Southern Highland conditions in Tanzania and quantify the probability of yield response by changing the potassium source from MOP to POLY4.

METHODOLOGY

- Six corn trials were established in 2014–15 in the Southern Highlands of Tanzania. Locations were selected to represent the major corn growing belt of Southern Highland conditions. Composite soil samples from a depth of 0–25 cm were taken from the experimental sites with the results listed in **Table 1**.
- All experiments were sown in the month of November with the onset of rains. Land preparation involved a deep cultivation followed by discing. Manual weeding was done in each experiment twice, at 20 and 40 days after sowing (DAS). Irrigation followed the standard practices.
- Treatments were the same at all sites except at Ismani, where N and P_2O_5 were applied at the rate of 80 and 46 kg ha^{-1} respectively. Nitrogen was applied twice; at pre-planting and 40 DAS and V6 growth stage. Entire phosphorus and potassium fertilizer doses were applied seven days before planting.
- Experimental design at each site was a randomised complete block design with four replications. Each experimental plot was 6 m x 5 m. Spacing between rows was 75 cm and between plants was 30 cm. Genotype UH 615 was sown at 125 kg ha^{-1}.
- Statistical analysis was carried out using GenStat software version 17 (VSN International, 2011) using ANOVA. Due to interest in the comparison of specific treatments, data was analysed at each location using single degree freedom orthogonal contrasts whenever the p value was less than 0.1.

Variable/nutrient	N	P_2O_5	K_2O	CaO	MgO	S
Control	0	0	0	0	0	0
NP	120	68	0	0	0	0
MOP	120	68	20	0	0	0
POLY4	120	68	20	24	9	27
MOP + Kieserite	120	68	20	0	34	27

Table 2 – Nutrients applied by fertilizer at each site

RESULTS

- Data analysis by location indicated significantly lower yields for MOP when compared with NP, POLY4 and MOP+Kieserite at 1, 2 and 2 instances out of 5 responding sites. MOP recorded lower yields than NP, POLY4 and MOP+Kieserite numerically at 4, 5, and 4 out of 5 locations respectively (**Figure 1**).
- No significant differences between NP, POLY4 or MOP+Kieserite were observed at all locations. However, POLY4 recorded numerically higher yield than NP at 4 out of 5 responding locations. The average difference across the locations was 218 kg ha^{-1} (**Figure 1**).
- In comparison, MOP+Kieserite recorded numerically higher yields than the NP treatment at 3 out of 5 responding locations. The average difference across the locations was 53 kg ha^{-1} (**Figure 1**).
- Ismani did not respond to fertilizer application thus is excluded from analysis.

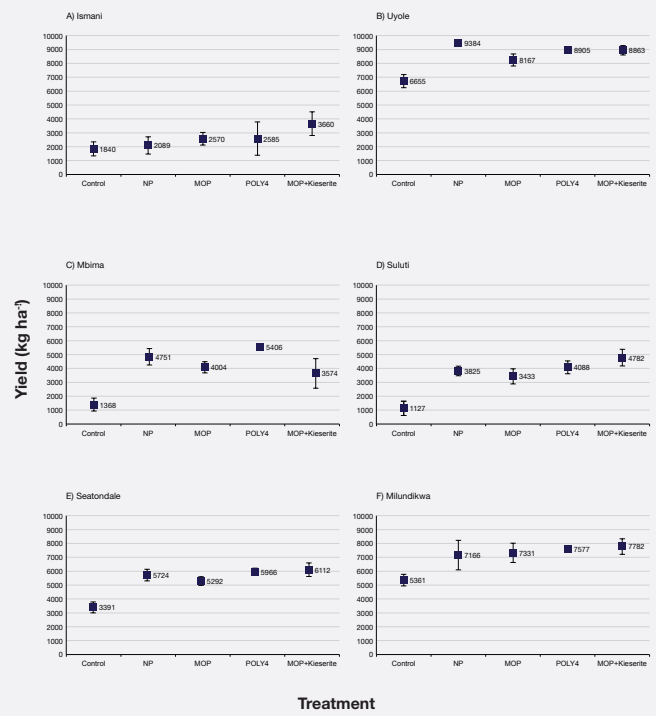

Figure 1 – Effect of treatments on corn grain yield(kg ha^{-1}) at six different locations in Southern Highlands of Tanzania. Error bars indicate the standard error of mean.

Vigour

- Crop vigour was measured at six locations (**Figure 2**). Similar to yield, significant differences among treatments was observed at all six locations ($p<0.001$).
- In summary, no significant differences among NP, MOP, POLY4 and MOP+Kieserite were observed.
- POLY4 recorded numerically higher vigour than NP, MOP and MOP+Kieserite at 4, 3 and 1 locations out of 6 respectively.

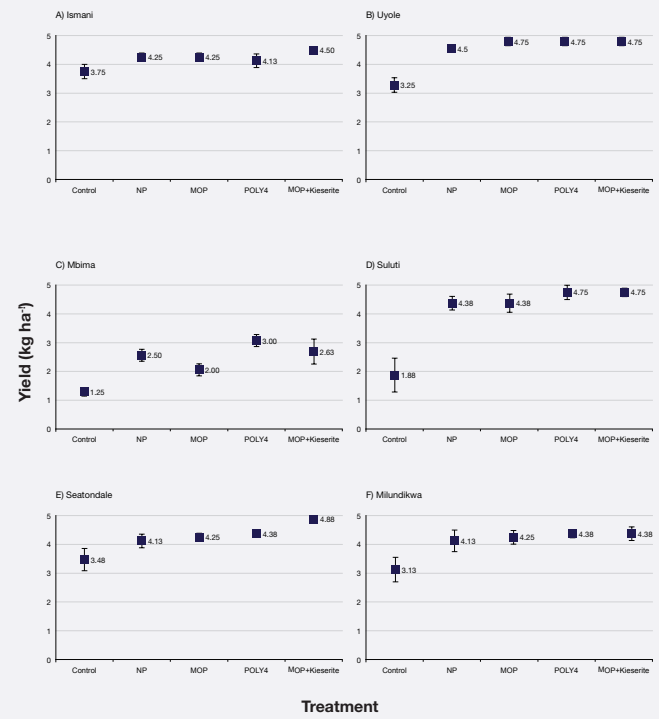

Figure 2 – Effect of treatments on corn vigour at five different locations in Southern Highlands of Tanzania. Error bars indicate the standard error of mean.

Variable/ trial name	Ismani	Uyole	Mbimba	Suluti	Seatondale	Milundikwa
pH (H_2O)	5.6	5.6	5.2	5.3	5.5	5.5
SOM (g kg^{-1})	8.4	20	18.4	6.2	6.1	25.5
N (g kg^{-1})	2.4	1.7	2.2	2.1	1.8	2.5
P (mg kg^{-1})	4.2	2.1	5.2	10.1	13.3	5.2
CEC (cmol(+)/kg)	14.9	17.7	15.8	12.1	4.9	16.3
K (mg kg^{-1})	234	917	246	230	117	445
Ca (mg kg^{-1})	774	1240	394	270	356	944
Mg (mg kg^{-1})	403	149	149	210	192	257
S (mg kg^{-1})	36.3	13.0	15.7	12.0	20.2	9.2
Texture	Sandy clay	Sandy clay loam	Clay	Sandy clay	Sandy loam	Sandy clay

Table 1 – Summary of soil analysis at each site

CONCLUSION

- Straight MOP application did not increased corn grain yield at any of the six locations tested, but significantly depressed yield in one instance. MOP recorded numerically lower yields than the NP treatment in 4 out of 6 instances.
- POLY4 significantly increased yield at 1 of 5 responding sites and numerically enhanced yield at 5 out of 6 sites under the Southern Highland conditions of Tanzania. MOP+Kieserite generally performed in a similar way to POLY4, indicating the significance of sulphur nutrition when looking to increase corn grain yield.
- Comprehensive research including tissue and post-harvest soil nutrient analysis is essential for confirming, explaining the reasons and mechanisms of the observed results.