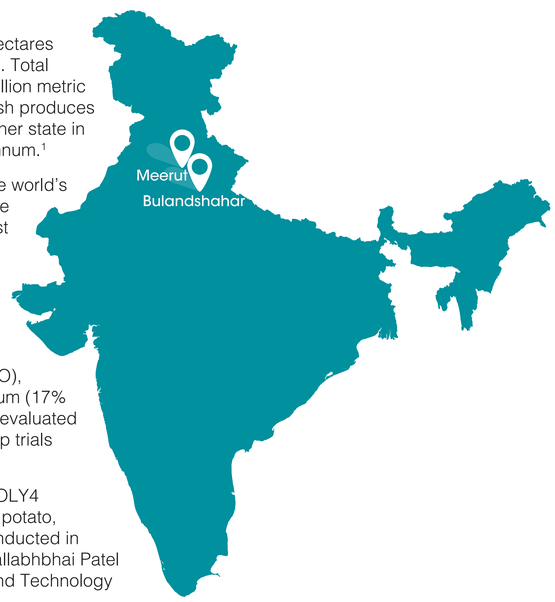
EFFECT OF POLY4 ON GROWTH AND YIELD OF POTATO IN SOILS OF WESTERN PLAIN ZONE OF UTTAR PRADESH, INDIA

Shahi U[1], Neeraj Awasthi[2], Rachel Fields[2], Dhyani B P[1], Ashok Kumar[1], Sanjay Rawal[1], Prem Singh[1]

1) SVBPU Ag.&Tech, Meerut, India; 2) Sirius Minerals, Scarborough, United Kingdom

Introduction

- India planted 2.2 million hectares of potatoes in 2017 – 2018. Total annual production is 49 Million metric tonnes (Mmt). Uttar Pradesh produces more potatoes than any other state in India with 13.9 Mmt per annum.[1]
- The recent discovery of the world's largest deposit of polyhalite (POLY4) has raised interest due to the mineral being used as a multi-nutrient fertilizer. POLY4 (K_2SO_4.$MgSO_4$.$2CaSO_4$.$2H_2O$) is an evaporite mineral that contains potassium (14% K_2O), magnesium (6% MgO), sulphur (19% S) and calcium (17% CaO). It is currently being evaluated as a fertilizer source in crop trials across the world.
- To assess the impact of POLY4 on the growth and yield of potato, field experiments were conducted in conjunction with Sardar Vallabhbhai Patel University of Agriculture and Technology (SVPUAT), Uttar Pradesh.



Methods

- Trials were run in Uttar Pradesh in Meerut and Bulandshahar.
- The frying potato variety Kufri Chipsona-1 was used in Meerut. The table variety Kufri Bahar was used in Bulandshahar.
- MOP is the locally-typical K fertilizer. S is traditionally applied to potatoes as elemental sulphur mixed with bentonite.
- The growth and yield of potatoes were measured after application of POLY4 and MOP at 50, 100 and 150% of the recommended rate which was 100 kg K_2O ha^{-1} at Bulandshahar (Table 1) and 150 kg K_2O ha^{-1} at Meerut. S was applied as bentonite in MOP treatments at rates equivalent to those supplied by POLY4.
- Each plot received 80 kg P_2O_5 ha^{-1} from DAP. Meerut received 270 kg N ha^{-1} and Bulandshahar received 180 kg N ha^{-1} from urea and DAP.
- Plant heights were measured at 60 days after planting (DAP). Leaf area index (LAI) and SPAD were also measured.
- Potato yield was measured for both marketable and non-marketable (< 25 g) tubers. Potato quality was determined by dry matter content (DM%) in the tubers.
- The trial was a randomized complete block with three replications.
- Results presented are based on data from Genstat factorial plus added control. Fisher's protected least significant difference post hoc test was used to compare means when the ANOVA was significant (α = 0.05).

Table 1 **Bulandshahar treatment table**[2,3]

Treatments	Nutrients applied (kg ha^{-1})			
	K_2O	S	CaO	MgO
N + P (control)	0	0	0	0
POLY4 50	50	68	61	21
POLY4 100	100	136	121	43
POLY4 150	150	204	182	64
MOP50 + S	50	68	0	0
MOP100 + S	100	136	0	0
MOP150 + S	150	204	0	0

Plant growth and development

- Increased plant height and LAI allow plants to capture more light for photosynthesis and shade-out weeds that otherwise compete for light, nutrients and water.
- Across both sites, POLY4-fertilized potato plants were taller (P = 0.001; Figure 1) and had 8% greater LAI (P = 0.03; Figure 2) than the MOP + S and N + P (control) treatments. Improvement in LAI also reflected better nutrient use efficiency.
- SPAD quantifies the greenness of leaves and therefore their photosynthetic capacity.
- POLY4-fertilized potato plants had greener (P = 0.005) leaves (+3% SPAD) than the MOP + S and N + P (control) treatments (Figure 3). Higher SPAD reflects an improvement in chlorophyll content in leaves, which increases sunlight absorption and crop growth.
- Potatoes at the Bulandshahar site had greater LAI and SPAD (P < 0.05) than at Meerut. There were no interactions (P > 0.1) between location and fertilizer type on SPAD, LAI or plant height.

Figure 1 **Average height (cm) 60 days after planting (DAP) across both sites**[4,5]

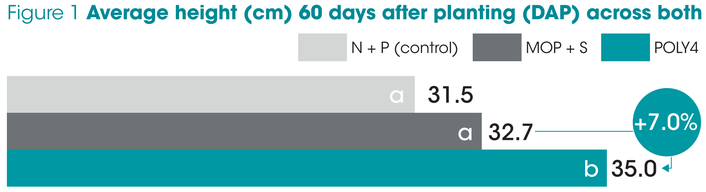


Figure 2 **Average leaf area index across both sites**[4,5]

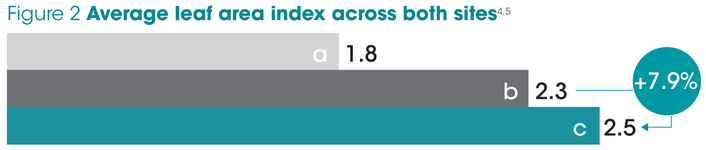


Figure 3 **Average SPAD value across both sites**[4,5]

Tuber yield

Figure 6 **Total marketable tuber yield – Meerut**[5]

- Processing potatoes are generally responsive to potassium.
- At Meerut, POLY4 significantly (P = 0.04) increased average marketable potato yield compared to MOP + S from 21.0 to 22.9 t ha^{-1}.
- At the recommended application rate (150 kg K_2O ha^{-1}), POLY4 increased marketable yield by 14% compared to MOP + S (Figure 6).

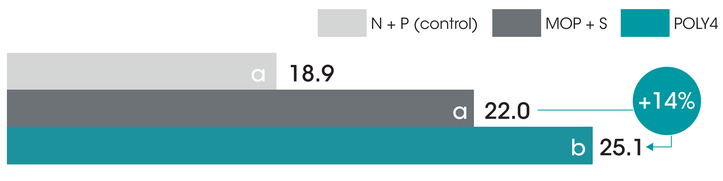
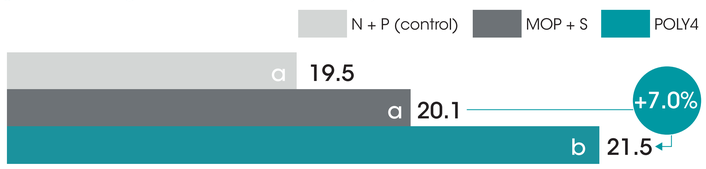


Figure 7 **Total marketable tuber yield – Bulandshahar**[5]

- At Bulandshahar, POLY4 significantly (P = 0.001) increased average marketable potato yield compared to MOP + S from 22 to 26 t ha^{-1}.
- At the recommended application rate (100 kg K_2O ha^{-1}), POLY4 increased marketable yield by 15% compared to MOP + S (Figure 7).

Potato quality: dry matter content

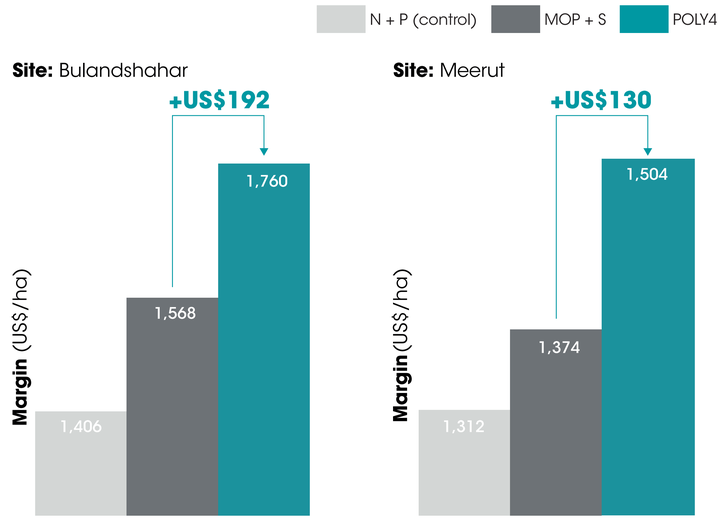
Figure 8 **Average dry matter content (%) at Meerut**[4,5]



- Potatoes with higher dry matter content (DM%) are more suitable for frying and attract a price premium. However, excess potassium and chloride application can reduce DM%.
- The frying cultivar tested at Meerut had greater (P = 0.003) DM% than the table cultivar at Bulandshahar.
- At Meerut, POLY4 gave significantly (P < 0.001) higher DM% than MOP + S and the N + P (control). On average, POLY4 increased tuber DM% compared to MOP + S from 20.1% to 21.5% (Figure 8).
- At Bulandshahar DM% was maintained in all treatments, with 19.0%, 19.1% and 19.3% in the control, MOP + S and POLY4, respectively.

Economic benefit[6]

- The POLY4 option produced greater yields which translated into an increase in financial margin at both sites.
- At the recommended K_2O application rates, POLY4 improved margins by US$192/ha at Bulandshahar and US$130/ha at Meerut.



Note: 1) Statistics of Horticulture, Ministry of Agriculture & Farmers Welfare, India (2017); 2) Treatment table is based on the recommended K_2O rate for Bulandshahar of 100 kg K_2O ha^{-1}. At Meerut the recommended K_2O rate was 150 kg K_2O ha^{-1} thus all nutrients at Meerut were 1.5 times greater than those displayed in the treatment table. MOP + S contained elemental sulphur with bentonite. N source was urea and P source was diammonium phosphate (DAP). Bulandshahar treatments received 180 kg N ha^{-1} and 80 kg P_2O_5 ha^{-1}. Meerut treatments received 270 kg N ha^{-1} and 80 kg P_2O_5 ha^{-1}; 3) Bulandshahar initial soil analysis: pH 7.5; EC 0.33 dS m^{-1}; 63 mg N kg^{-1}; 7.3 mg P kg^{-1}; 70.8 mg K kg^{-1}; and 7.0 mg S kg^{-1}. Meerut initial soil analysis: pH 8.1; EC 0.33 dS m^{-1}; 69 mg N kg^{-1}; 9.5 mg P kg^{-1}; 112 mg K kg^{-1}; and 9.3 mg S kg^{-1}. pH and EC measured in a 1:2.5 soil:water extraction; 4) Average of all K_2O rates; 5) Fisher's least significant difference (LSD) post hoc test was used to separate means when the ANOVA was significant (α = 0.05). Different letters denote treatments are significantly different (P < 0.05). 6) Margin = output (yield times price) minus fertilizer cost and spreading cost. Prices are based on local prices supplied by regional agronomist: urea (US$85/t), DAP (US$315 /t), MOP (US$194/t), bentonite (US$270/t), POLY4 (US$200/t), potato (US$75/t).

Source: Sardar Vallabhbhai Patel University (2018) 76000-SVPU-76010-17