Potato yield and dry matter response to different sources of potassium fertilizer in England

Kiran Pavuluri[1], Timothy D Lewis[1] and Robert Meakin[1]

(1) Sirius Minerals PLC, Manor Garth, Scarborough YO11 3TU, UK

Abstract

Limited available information pertaining to the performance of polyhalite (14% K_2O, 20% CaO, 6% MgO and 20% S, POLY4®) on potato prompted establishment of a trial on loamy soils in Staffordshire, England in 2015. The first objective was to assess three different sources of potassium: Muriate of Potash (MOP), Sulphate of Potash (SOP), and POLY4 at 0 (Control), 100, 200, 300 and 400 kg K_2O ha^{-1} supplying different rates of Mg, S and Ca. All treatments received standard N and P nutrients. Each source of potassium was similar for yield and each resulted in higher tuber yield than the control. POLY4 and control recorded significantly higher dry matter content than MOP treatment. The second objective was to measure the suitability of different combinations of POLY4 and MOP meeting total crop K_2O requirements and varied MgO requirements. Single degree freedom contrasts were used to compare the treatments of interest. MOP resulted in similar yield to control. Treatments containing POLY4 in different proportions resulted in significantly higher yield than the control. Results indicate the effectiveness of POLY4 both as a straight fertilizer or combined with MOP to meet the potato nutrient requirements.

Introduction

- Potassium nutrition in potato is critical for yield, quality and marketability.
- On an average, 221 kg K_2O ha^{-1} potassium fertilizer is applied for potato in the UK
- SOP is preferred over MOP due to its role in maintaining the dry matter percentage
- Potassium and magnesium are two key nutrients required for potatoes, which can have restricted availability due to the ionic antagonism of the potassium and magnesium that in turn limits yields
- There is an enhanced interest in the usage of polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$; POLY4®) due to the recent successful exploration for polyhalite in North Yorkshire. The ratio of potassium to magnesium in POLY4 appears favourable for potato growers but limited information is available on POLY4 performance for potatoes in Europe
- POLY4® is an alternate potassium sources to MOP and SOP, SOPM having advantage in terms of cost of production and availability in large scale. This could ultimately lead to decreased reliance on SOP as a potassium source for potato

Objectives

- To generate and compare the potassium rate response curves of MOP, SOP and POLY4 for tuber yields
- To understand whether MOP and POLY4 combinations perform better than MOP and NP control practises for tuber yield and dry matter percentage

Methods

- The trial was established on loamy soils in Staffordshire, England with an initial soil analysis of P 28 mg kg^{-1}, K 106 mg kg^{-1} and Mg 44 mg kg^{-1}
- The genotype planted was Pentland Dell
- The previous crop was winter wheat and planting and treatment application were completed on 28th April 2015
- Ammonium nitrate provided 170 N kg ha^{-1} and triple super phosphate provided 100 P_2O_5 kg ha^{-1} and was applied two days before planting
- Another 50 kg of N from Ammonium nitrate was applied 34 days after planting resulting in a total N application of 220 kg ha^{-1}
- Treatments according to Table 1 and 2 were replicated 4 times in a randomized block design and were applied to a destoned bed and incorporated with a nematicide prior to planting
- Each plot has 2 beds containing 4 rows of potato crop and a length of 10 metres
- Foliage was killed on 9th October 2015. Crop was irrigated twice during the growth period. All other agronomic operations were carried out as per the standard local practise

Treatments

Table 1 – Type, rate and amount of the nutrients supplied by each treatment for rate response study

Treatment/ Variables	Fert-ilizer applied (kg ha^{-1})			Nutrients applied (kg ha^{-1})				
	MOP	SOP	POLY4	K_2O	MgO	CaO	S	Cl
1	-	-	-	-	-	-	-	-
2	167	-	-	100	-	-	-	80
3	333	-	-	200	-	-	-	160
4	500	-	-	300	-	-	-	240
5	667	-	-	400	-	-	-	320
6	-	200	-	100	-	-	34	21
7	-	400	-	200	-	-	68	43
8	-	600	-	300	-	-	102	64
9	-	800	-	400	-	-	136	86
10	-	-	714	100	43	121	136	6
11	-	-	1429	200	86	243	272	12
12	-	-	2143	300	129	364	407	18
13	-	-	2857	400	171	486	543	24

Table 2 – Type and amount of the nutrients supplied by each treatment for source evaluation study

Treatment/ Variables	Fertilizer applied (kg ha^{-1})			Nutrients applied (kg ha^{-1})				
	MOP	POLY4	Kieserite	K_2O	MgO	CaO	S	Cl
1	-	-	-	-	-	-	-	-
2	-	-	320	-	80	-	64	-
3	500	-	-	300	-	-	-	240
4	420	343	-	300	21	58	65	212
5	376	530	-	300	32	90	253	196
6	190	1330	-	300	80	226	34	131
7	-	2140	-	300	128	364	407	64
8	420	343	238	300	80	58	113	212
9	376	530	192	300	80	90	139	196

Statistical analysis

Statistical analysis was carried out using GenStat software version 17 (VSN International, 2011) using ANOVA and regression analysis. Treatments of interest in source study were compared by using single degree of freedom contrasts.

Results – Rate Response study

Table 3 - Analysis of variance p values for the measured variables in rate response study

Variable	Control	Control * Type	Control * Rate	Control * Type * Rate
Tuber Dry Matter (%)	0.054	0.028	ns	0.004
Yield (t ha^{-1})	<.001	ns	ns	ns
Yield > 45mm in diameter (t ha^{-1})	<.001	ns	ns	ns
Yield_50mm (t ha^{-1})	<.001	ns	ns	ns
10 kg Tuber Count (No. of potatoes)	0.058	ns	ns	ns
Marketable Yield (%)	0.071	ns	ns	ns

MOP SOP POLY4

Figure 1 – Examples of potatoes harvested from each fertilizer plan

- Potassium application irrespective of source significantly improved potato yield above the control of N and P
- No significant differences were observed between MOP, SOP or POLY4. However, potato yields were 2% i.e. 1.2 t ha^{-1} (mean of the 100, 200, 300 and 400 kg K_2O ha^{-1}) higher for POLY4 treatments than the MOP or SOP treatments

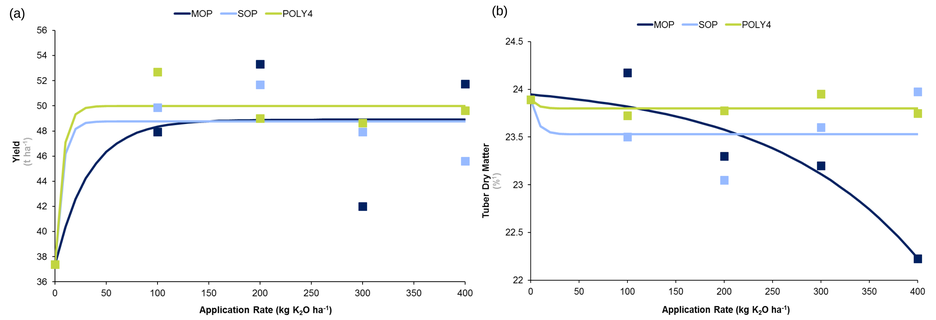

Figure 2 – Regression plot fresh tuber yield (a) and tuber dry matter (b)

Table 4 – Regression analysis of tuber yield and dry matter

Treatment/ Variables	Yield (t ha^{-1})			Tuber dry matter (%)		
	Equation	r^2	*p*	Equation	r^2	*p*
MOP	$y = 48.9\text{-}1.52*(0.9704^X)$	0.39	<0.001	$y = 24.085\text{-}0.14*(1.00648^X)$	0.3	0.005
SOP	$y = 48.77\text{-}11.39*(0.863^X)$	0.46	<0.001	$y = 23.53+0.3604*(0.863^X)$	n/a	0.501
POLY4	$y = 49.98\text{-}12.6*(0.863^X)$	0.61	<0.001	$y = 23.8+0.09167*(0.863^X)$	n/a	0.965

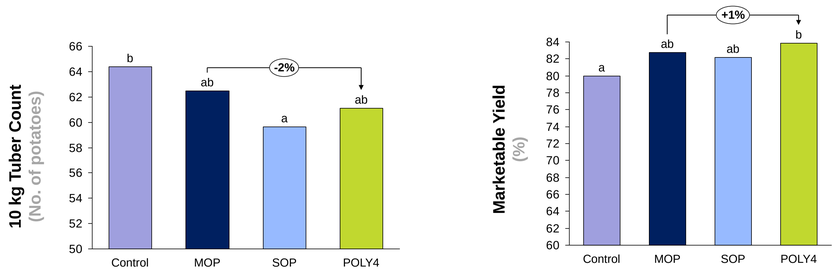

Figure 3 – Tuber count and percentage marketable yield

Results – Potassium combinations study at recommended K_2O rate

- All the combinations containing MOP and POLY4 significantly outperformed NP control. However, 100% K source as MOP treatment was on par with NP control. This indicate the value of adding POLY4 in crop fertilizer program. This could be due to the contribution of magnesium from POLY4
- Supply of additional 48 kg of MgO through Kieserite to MOP + POLY4 (75%:25%) combination significantly enhanced yields than 100% MOP treatment. These results confirm the importance of both potassium and magnesium to the enhancement of tuber yields

Table 5 - Analysis of variance p values for the measured variables in K combination study

Variable	Type
Tuber Dry Matter (%)	ns
Yield (t ha^{-1})	0.009
Yield > 45mm in diameter (t ha^{-1})	0.002
Yield_50mm (t ha^{-1})	ns
10 kg Tuber Count (No. of potatoes)	ns
Marketable Yield (%)	0.059

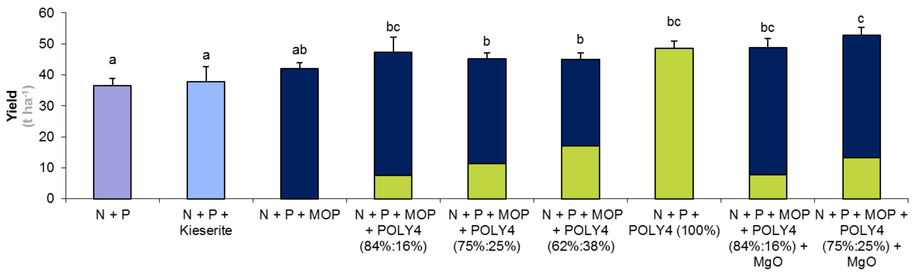

Figure 4 – Total potato yields under different potassium fertilizer combinations

Conclusions

- The rate response study of potassium fertilizers showed POLY4 to be more effective at improving yields than MOP but similar to SOP
- Decreasing dry matter percentage with increasing K_2O rate was observed for MOP but not for SOP or POLY4 treatments
- POLY4 and MOP combinations recorded numerically higher yields than 100% K source as MOP which is in turn on par with control. However, combinations of MOP and POLY4 recorded significantly higher tuber yield than control

Scan to learn more about POLY4

Scan for digital copy of this poster