POLY4 AS A FERTILIZER FOR COTTON IN VIRGINIA, USA

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Background

Polyhalite is a naturally occurring mineral that has a long-demonstrated value as a source of potassium (Fraps and Schmidt, 1932; Mercik, 1981; Barbarick, 1989), sulphur (Mercik, 1981) and magnesium (Panitkin, 1997; Boguszweski, 1967). POLY4 is the trademark name for Sirius Minerals' high grade polyhalite product, mined in the UK, that provides a multi-nutrient fertilizer suitable for a broad range of crops. Sirius Minerals' have completed trials globally (240+ trials, 2 crops, 17 countries, five continents) to support and demonstrate this.

Trial

A field trial was conducted by Virginia Tech in 2016. The trial was grown in a commercial cotton crop according to local practice. The site was chosen to represent a local typically nutrient-poor soil.

Mehlich I extraction (mg kg^{-1}) and classification in parentheses					
P	K	Ca	Mg	pH	S
23 (H-)	18 (L)	345 (L+)	40 (M-)	6.0	34

Treatments and analysis

The trial was designed to determine a response of cotton to potassium in POLY4 and other commercial fertilizers (MOP: muriate of potash) and analogous blends (MOP-balanced). The MOP+kieserite blend targeted an alternative K, Mg and S application to the POLY4 treatment.

All fertilizers were broadcast immediately before planting. The control received N and P but no K. The K treatments were applied for all fertilizers at 33, 67, 100 and 134 kg K_2O ha^{-1}.

FERTILIZER	APPLICATION RATE (kg ha^{-1})					
	N	K_2O	MgO	CaO	S	Cl^-
Control	112	0	0	0	0	0
MOP (0:0:60)	112	100	0	0	0	80
POLY4 (0:0:14+17% CaO+6% MgO+19% S)	112	100	43	120	137	21
MOP+POLY4 (50:50)	112	100	21	60	68	51
MOP balanced (MOP and kieserite:25% MgO+21% S)	112	100	18	51	52	80

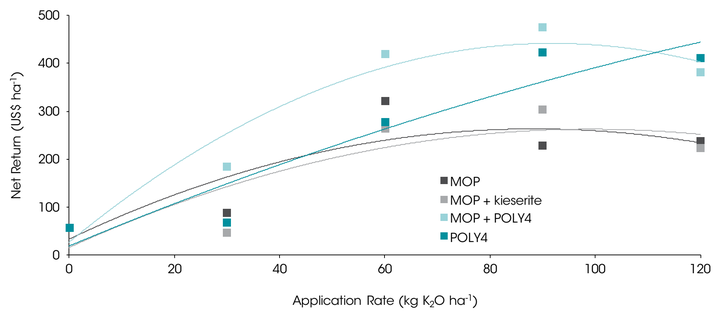
Treatments were randomised in a factorial design and replicated four times. Plot size was $45m^2$.

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

Yield results

The yield of cotton lint was generally low during a dry growing season (average yield in Virginia for unirrigated cotton ca. 900 kg lint ha^{-1}). However, there was a significant response to both the K fertilizer rate and type ($p<0.001$) (Figure 1). The K response for each fertilizer was best fitted with quadratic equations (p values <0.05; r^2 28-67%). The 50:50 blend of POLY4 and MOP produced the greatest yields (average 365kg lint ha^{-1}) and significantly more yield than both the MOP (219kg lint ha^{-1}) and MOP+kieserite (210 kg lint ha^{-1}).

Figure 1: Lint yield of cotton after K fertilizer treatments

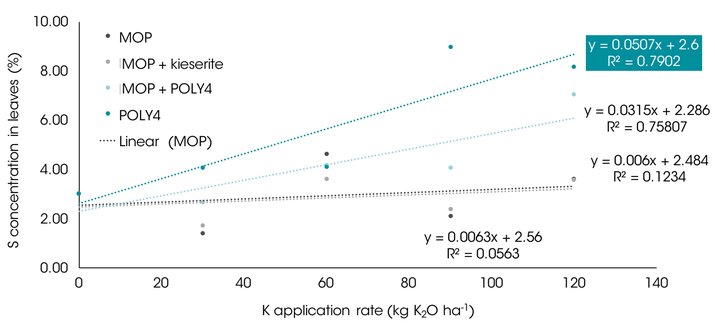


Nutrient uptake

None of the treatments significantly affected N, K, Ca or Mg uptake ($p>0.10$). However, there was a consistent trend for POLY4 treatments to increase S uptake and concentrations (Figure 4). The same trends were repeated for the S concentrations and uptake in the cotton bracts, seed, leaves and stems (data not shown) and the total crop (Figure 2).

- The POLY4 treatments applied an average 137 kg S ha^{-1} and produced the most rapid increase in crop S concentrations. These treatments also provided the greatest increase in leaf mass (data not shown) and total S uptake.
- The MOP+POLY4 mixture applied an intermediate amount of S (average 68kg S ha^{-1}) and delivered intermediate increases in crop S concentrations and total S uptake.
- The MOP applied no S and did not increase the crops S uptake or concentrations.
- The MOP+kieserite treatments were designed to closely match the S applied (average 52 kg S ha^{-1}) by the MOP+POLY4 blend. Interestingly, these S applications did not provide the same increase in crop S uptake or concentrations as either of the POLY4 fertilizers. Indeed, the treatments containing kieserite did not increase the S concentrations or S uptake and remained consistently similar to the MOP fertilizer-only analogues.

Figure 2: Total crop uptake of S leaves after different fertilizer applications

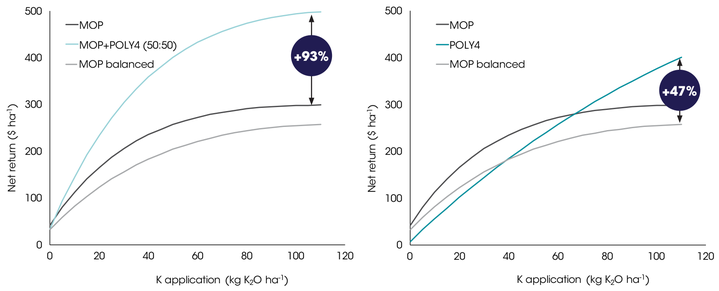


Financial analysis

The MOP+kieserite blend was designed as a commercial alternative to POLY4. Both supply balanced sources of multi nutrients.

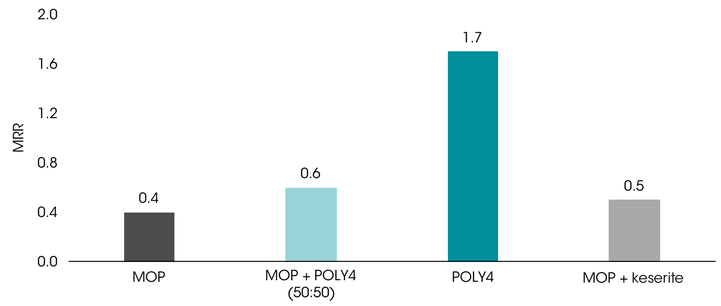
At locally optimal K application rates the MOP+POLY4 blend increased net returns by 47% compared to the MOP+kieserite (Figure 3). The 50:50 blend of MOP+POLY4 increased net returns by 93% compared to the competitive MOP+kieserite blend.

Figure 3: Net return for fertilizer treatments applied to cotton



An acceptable potassium fertilizer rate (100 kg k_2O ha^{-1}) was chosen as representative of local usage to compare marginal rates of return (MRR). POLY4 had a far greater MRR than all other fertilizer sources (Figure 4).

Figure 4: Marginal rate of return at commercial K fertilizer rates for different K sources



A similar pattern was repeated for the value-cost ratio (VCR) – data not presented.

Conclusions

- Increasing K application across four fertilizer types consistently increased lint yield in cotton, despite challenging growing conditions.
- Treatments containing POLY4 were most effective at increasing lint yield. This led to a large increase in grower returns and greatly improved financial metrics for fertilizer use, particularly compared to MOP or the MOP+kieserite blend. It, therefore, appears likely that the increase in yields with POLY4 was driven by its multi-nutrient nature.
- The application of greater quantities of S through POLY4 consistently increased both crop S concentrations and uptake. Such increases were not affected by the comparable quantity of S applied in the MOP+kieserite blend.