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 locally typical nutrient-poor soil.

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 K2O ha⁻¹.

<table>
<thead>
<tr>
<th>Mehllich I extraction (mg kg⁻¹) and classification in parentheses</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>pH</th>
<th>S</th>
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<tbody>
<tr>
<td>23 (H⁻)</td>
<td>18 (L⁺)</td>
<td>345 (L⁺)</td>
<td>40 (M⁻)</td>
<td>6.0</td>
<td>34</td>
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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; r² 26-67%). The 50:50 blend of POLY4 and MOP produced the greatest yields (average 865kg 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](image)

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 2). 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 68kg 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](image)

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](image)

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.