Selenium uptake in Ryegrass with applied Sulphur fertilizers

- understanding selenate - sulphate competition

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Introduction

There is a growing need for sulphur fertilizer applications following progressive reduction in coal burning which previously resulted in sufficient sulphur deposition. There is also an increased awareness of the health benefits of biofortification of staple crops with selenium. However sulphate and selenate compete for uptake via plant roots as they share the same root transporter. This research aimed to understand and test a range of options to minimise this antagonistic reaction, including comparison of the effects of tradition and slow-release sulphur fertilizers on Se uptake in a pot trial using stable isotope spikes of selenium.

Materials and Methods

Ryegrass (*Lolium multiflorum*) was grown from seed in 2 L pots on a sandy loam soil (reps=5). Selenium spikes (0 or 20 g ha^{-1}) of mixed $^{74}Se^{VI} + {}^{77}Se^{IV}$ were applied either by fertigation (FG) where 120 ml solution was added, or by liquid placement (LP) where 3 additions of 1 ml each were placed on the surface of the soil at specific locations. Granular sulphur fertilizers (Polysulphate™, $MgSO_4$, PotashpluS37™ and PatentKali®) were supplied at 60 kg S ha^{-1} and gypsum was supplied at 5.1 Mg ha^{-1}. Both selenium and sulphur fertilizers were applied two weeks after an initial cut of the ryegrass. Ryegrass was then harvested every 35 days on a further four occasions. Samples were oven dried at 50 ℃ over 3 days before milling and microwave (HNO_3) digestion before analysis by ICP-MS.

Results and Discussion

Table 1: Sulphate fertilizers

Sulphate Compounds	Abbreviation
Polysulphate™	Poly
$MgSO_4$	$MgSO_4$
Potashplus37™	Potash37
PatentKali®	SMP
Gypsum	Gypsum

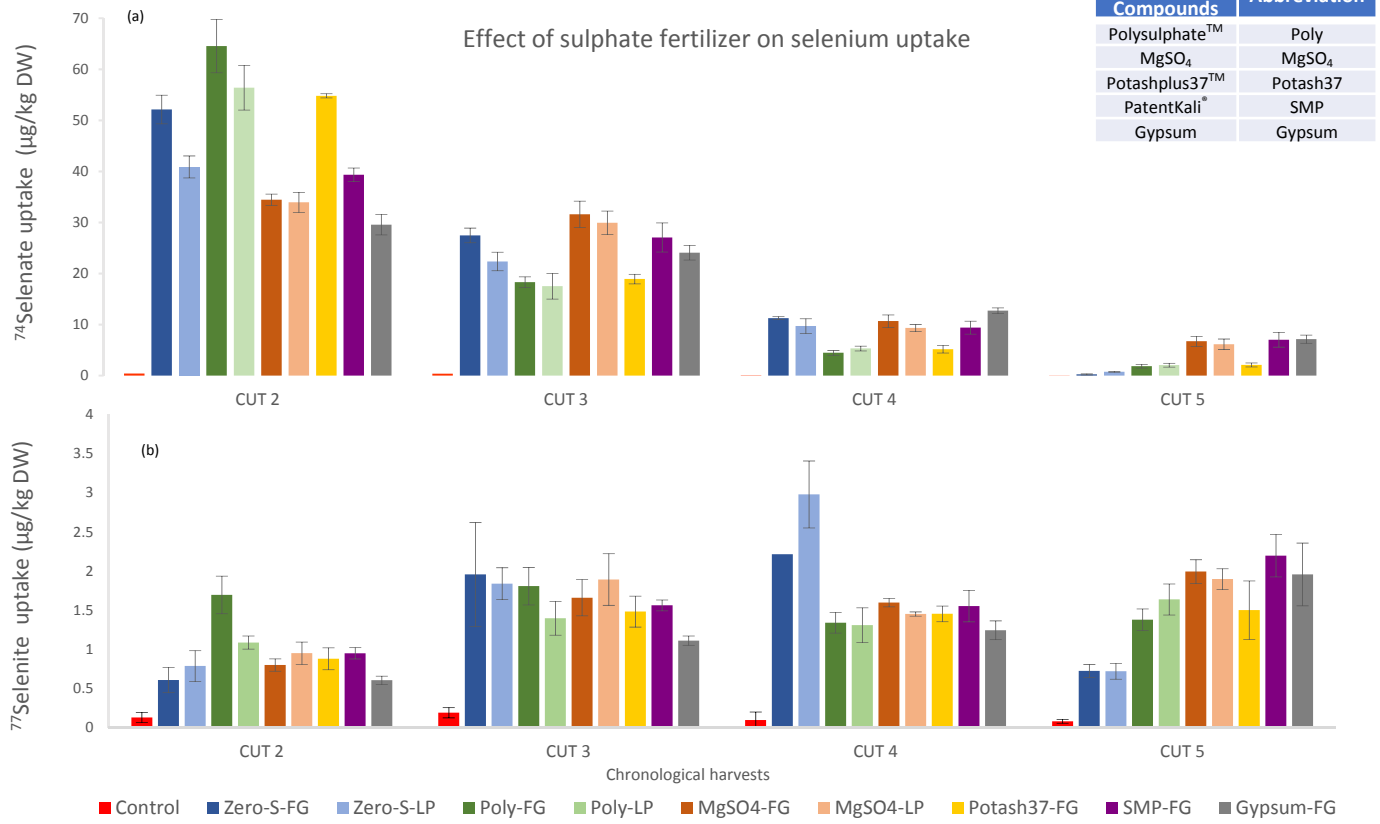

Figure 1: Effect of applied sulphate compounds on Se (VI) (**1a**) and Se (VI) (**1b**) uptake supplied as 20 g ha^{-1} $^{74}Se(VI)$ + 20 g ha^{-1} $^{77}Se(IV)$ two weeks after cut 1.

- Selenate was more bioavailable than selenite in this trial (Figure 1). The difference between the amount of selenium taken up as selenate and as selenite declines with time suggesting fixation and conversion of the applied selenate in the soil.
- Selenate uptake was initially greater when S was applied as polyhalite (cut 2, Figure 1a) when compared to other sulphate treatments, but was supressed in subsequent cuts. This may suggest that the slow release of S is beneficial for Se uptake, promoting transport of both S and Se into the plant without suppressing Se uptake with the presence of large amounts of S. Soluble $MgSO_4$ significantly suppressed Se (VI) uptake in cut 2 but enhanced its uptake in cut 3. This may be because the high S concentrations have decreased allowing the plant to uptake the selenate before it becomes fixed in the soil and uptake declines (cuts 4 & 5).
- The selenium application method does not appear to affect uptake in a systematic way in application of 20 g ha^{-1} Se.

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