Elemental Sulphur as a fertiliser source in Western Australia

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KEY MESSAGES

Wheat has a low efficiency of utilisation of sulphate applied at seeding on high rainfall, sand plain country. This is due to (i) the soils having a low capacity to adsorb sulphate, and (ii) leaching rainfall in June and July. An alterative source of sulphur is elemental S. Experimental results confirm elemental S is a good slow release fertiliser and not subject to loss by leaching. It was hypothesised that soils with a history of elemental S application will have a higher rate of elemental S oxidation than soils without such a history. However, this was not supported by the results from either the column or glasshouse experiments. It appeared the native microbial populations which oxidise elemental S to sulphate were able to response quickly to additions of elemental S, and a priming effect of a history of elemental S application might not be required for rapid oxidation of elemental S. For elemental sulphur to be an effective fertiliser, the particle size of the material needs to be less than 0.2 mm. At this particle size elemental sulphur is oxidised by the soil micro-organisms at a sufficient rate to satisfy plant demand for sulphur.

AIMS

The aim of the study was to examine factors which influence the effectiveness of elemental S as a sulphur fertiliser in WA agricultural soils. Two experiments were conducted in 2003. The aims of these experiments were;

(i) To compare leaching of ammonium sulphate and elemental S in cropping and pasture soils of different S fertiliser histories, and

(ii) To compare the root and shoot growth of canola (*Brassica napus* L.) fertilised with increasing rates of either ammonium sulphate or elemental S in pasture soils with different S fertiliser histories.

METHOD

Soil Column Experiment

The soils were collected from three farms near Piawanning. The sites had different land-use histories (crop or pasture) and different S fertiliser histories (sulphate S or elemental S).

A four-factor factorial experiment (land use history, S fertiliser history, S fertiliser source and application rates) was set up using soil columns. Elemental S and $(NH_4)_2SO_4$ at three rates (10, 50 and 250 mg S/kg) were applied to the top of pasture soil columns and were banded 5 cm deep for the cropping soils. The columns were then saturated to field capacity. Twenty mLs of DI water was applied daily for 42 days. Leachate was collected 8 times over this period. Sulphate content of the leachate was measured using the turbidimetric method.

Glasshouse Experiment

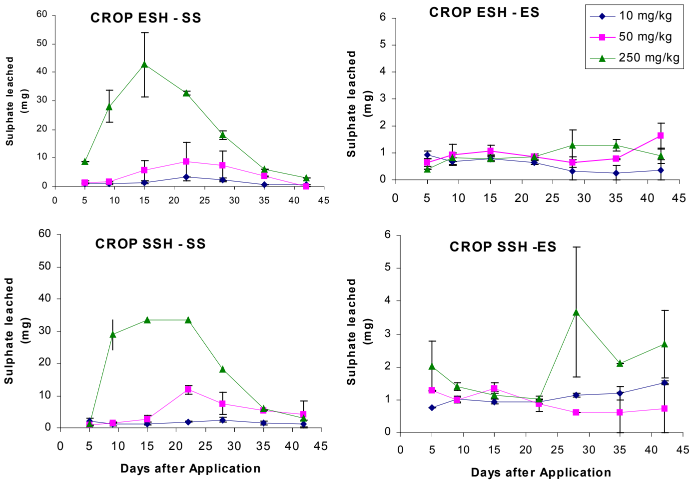
Canola (variety *Monty*) was grown in pots containing 3 kilograms of pasture soil. The experiment had three factors (S fertiliser sources and rates and soil S fertiliser history) and two replicates. Rates of S fertilisers were 0, 8, 16 and 32 mg S/kg soil. After 39 days of growth, the above-ground biomass was cut off just above the soil level and roots washed from the soil. Oven-dried roots and shoots (70^oC, 5 days) were weighed and analysed for S content.

RESULTS

Column Experiment

Pasture soils had a lower rate of sulphate leaching when fertilised with elemental S compared to sulphate S. This difference generally increased with an increasing rate of fertiliser application.

The largest amount of sulphate leaching occurred earlier for the cropping soils compared to pasture soils. This effect was due to the placement of the fertiliser below the soil surface in the case of the cropping soil compared to surface placement for pasture soils. Again, the cropping soil, which was fertilised with sulphate fertiliser, had greater amount of sulphate leaching compared to soils fertilised with elemental S (Fig 1).



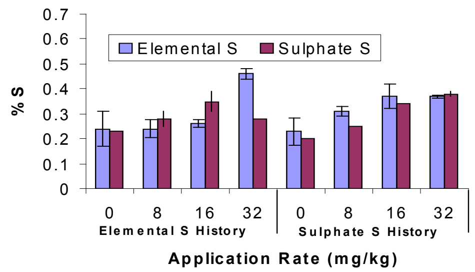


Fig 1. Leaching of sulphate from cropping soils of different S fertiliser histories (SSH=sulphate S, and ESH=elemental S history) fertilised with sulphate S (SS) and elemental S (ES) at three rates

Fig. 2. Sulphate concentration of canola root dry matter grown in soils of different S fertiliser histories (sulphate S or elemental S) that have received different forms of S (sulphate S or elemental S).

Glasshouse experiment

Shoot S content was greater when S fertiliser was sulphate S compared to the elemental S. In addition, shoot S content increased as the application rate of both S fertiliser sources increased. An increase in the application rate of sulphate S resulted directly in an increase in the amount of sulphate available for root uptake. In contrast, an increase in the amount of elemental S applied to the soil increased the surface area of contact between elemental S particles and S-oxidising micro-organisms, stimulating sulphate production for root uptake. The lack of significance between the fertilisers indicates that elemental S was equally effective as sulphate S in supplying sulphate to canola roots.

CONCLUSION

Sulphate S and elemental S fertilisers showed a similar capacity to supply sulphate to canola roots regardless of the fertiliser S history of the soil, suggesting that a priming effect of a history of elemental S application may not be required for rapid oxidation of elemental S. The low rate of sulphate leaching from the elemental S treatments suggests that elemental S has the potential to increase the efficiency of utilitation of S fertiliser applied at seeding in the cropping zone of Western Australia. However, given difficulties in handling elemental S of fine particle sizes, further research is required into procedures for incorporating fine elemental S into fertiliser granules.

KEY WORDS

Fertiliser, sulphate, elemental sulphur

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