Sulphur management in a three year rotation

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Key Findings

- The addition of sulphur increased wheat grain yield at both trial sites.
- Grain yield at the clay loam site was consistent for all of the sulphur rates, sources (gypsum and SoA) and application times tested.
- In contrast, there was variation in grain yield for the sulphur treatments tested at the sandy dune location due to the poor nutrient holding capacity of this soil type.

Why do the trial?

Over the past decade in the upper Northern Yorke Peninsula region, various crops have suffered from sulphur deficiency. This has been caused by the off take of sulphur greater than input. Both Sulphate of Ammonia (SoA) and gypsum are readily available sources of sulphur which can be applied to soil.

This research aims to establish product, rates and timings suitable to achieving the most economic return for managing sulphur deficiency. The trial will establish methods for managing sulphur over a medium term time frame (three years) in both sand dune and clay loam swale soil types.

How was it done?

Location	Bute, SA	**Fertiliser**	MAP (10:22) @ 90kg/ha on 11th May. Urea (46:0) applied to balance nitrogen rates across site. Sulphur applied as per rates listed in Table 1 and 2.
Plot size	1.5 m x 11.0 m		
Seeding date	11th May 2016		
Variety	Mace @ 60 kg/ha		

The trials were located across two sites in the paddock (1) red brown sandy clay loam in swale and (2) red sand on dune with moderate soil moisture at planting. Starting soil sulphur levels (KCl-40) were measured in 2015 and ranged from 1.8 – 2.6 mg S/kg for the sandy dune site and 2.2 – 4.7 mg S/ kg for the clay loam site (Table 1). All except one sample were below the current critical limit of 4.5 mg S/kg. The trial was established in 2015 to lentils and sulphur treatments are outlined in Tables 2 and 3. Total growing season rainfall in 2016 was 420 mm. All sulphur products were applied pre-planting on 11th of May. Clay loam treatments were replicated four times, sand dune replicated three times.

Crop assessments include early vigour, NDVI and grain yield.

Table 1. Soil properties (pH and EC) and available sulphur, (KCl-40), nitrogen (nitrate and ammonium) and phosphorus (DGT-P) for sand dune and clay loam trial sites on Yorke Peninsula, SA. Soil cores were taken in Autumn 2015.

Measurement		Sand dune			Clay loam		
		0 – 10 cm	10 – 30 cm	30 – 60 cm	0 – 10 cm	10 – 30 cm	30 – 60 cm
pH CaCl		7.16	7.38	7.7	7.69	7.83	8.27
EC 1:5	dS/m	0.1	0.09	0.07	0.1	0.12	0.18
Sulphur	mg/kg	1.9	1.8	2.6	2.2	4.7	3.7
Nitrate	mg/kg	3	1	1.4	1.9	5.8	2.9
Ammonium	mg/kg	3.1	2.8	1.6	2.1	2.1	1.6
DGT-P	ug/L	36			10		

Results and discussion

Wheat crop establishment and growth was excellent, due to good seasonal conditions. Ample nitrogen was applied to maximise yield potential with yields averaging 5.4 t/ha on the clay loam and 3.15 t/ha on the sand dune site. The potential for nitrogen to leach out of the system was high with heavy rainfall in Winter and late September. However, NDVI assessments taken during the growing season indicated no significant differences between the treatments.

A subset of plots were tissue sampled at GS32 (2nd node 2 cm above 1st node) in the nil, gypsum at 1 t/ha and SoA at 150 kg/ha. The results did not indicate any differences in sulphur content (data not shown) with the average leaf content of 0.4% sulphur.

All sulphur treatments significantly yielded above the nil untreated on the clay loam soil type (Table 2). At this site there was no differences between any of the gypsum or SoA sulphur treatments, with yield ranging from 5.28 to 5.63 t/ha. Interestingly, treatments where sulphur was applied in year one were able to yield as well as those which received a second application. This indicates the long-lasting benefits of both gypsum and SoA as a source of sulphur at this site.

Table 2. Summary of NDVI and wheat grain yield for sulphur treatments at the clay loam site, 2016. A tick in the year column indicates the corresponding sulphur treatment was applied in that year. Averages followed by the same letter do not significantly differ.

Site: Clay loam					NDVI	Yield	Yield
Trt No	**Product**	**Rate kg/ha**	**2015**	**2016**	**08-Aug**	**t/ha**	**% of nil**
3	Gypsum	3000	√		0.758	5.63[a]	119
6	SoA	150	√	√	0.771	5.60[a]	118
7	SoA	150	√		0.745	5.51[a]	116
8	SoA	100	√	√	0.742	5.51[a]	116
4	Gypsum	1000	√	√	0.726	5.49[a]	116
10	SoA	75	√	√	0.770	5.48[a]	116
5	SoA	300	√		0.748	5.45[a]	115
12	SoA	50	√	√	0.757	5.42[a]	114
2	Gypsum	1000	√		0.745	5.40[a]	114
9	SoA	150	√		0.752	5.28[a]	111
11	SoA	75	√		0.758	5.28[a]	111
1	Nil				0.741	4.74[b]	100
				CV	3.8%	6.8%	
				LSD (P≤0.05)	0.03	0.39	

On the sand dune site there was greater variation among the sulphur treatments tested with yields ranging from 2.93 t/ha – 3.60 t/ha. In 2016 all of the SoA treatments yielded above the nil however, the gypsum treatments did not (Table 3). Four out of the five highest yielding treatments on the sand dune had SoA applied in 2016. This indicates residual sulphur from the 2015 SoA treatments was minimal & likely leached out of the root zone in this sandier soil type (keep in mind that the 2015 lentils yielded very poorly).

Table 3. Summary of NDVI & wheat grain yield for sulphur treatments at the sand dune site, 2016. A tick in the year column indicates the corresponding sulphur treatment was applied in that year. Averages followed by the same letter do not significantly differ.

Site: Sand dune					**NDVI**	**Yield**	**Yield**
Trt No	**Product**	**Rate kg/ha**	**2015**	**2016**	**08-Aug**	**t/ha**	**% of nil**
6	SoA	150	√	√	0.743	3.60^{a}	131
10	SoA	75	√	√	0.762	3.41^{ab}	124
12	SoA	50	√	√	0.777	3.34^{abc}	122
5	SoA	300	√		0.758	3.14^{bcd}	114
7	SoA	150	√		0.732	3.18^{bcd}	116
8	SoA	100	√	√	0.747	3.17^{bcd}	116
9	SoA	150	√		0.755	3.10^{bcd}	113
2	gypsum	1000	√		0.748	3.06^{cde}	111
3	gypsum	3000	√		0.767	3.07^{cde}	112
4	gypsum	1000	√	√	0.767	3.00^{de}	109
11	SoA	75	√		0.766	2.93^{de}	107
1	Nil				0.738	2.75^{e}	100
				CV		6.5%	6%
				LSD (P≤0.05)		0.083	0.32

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