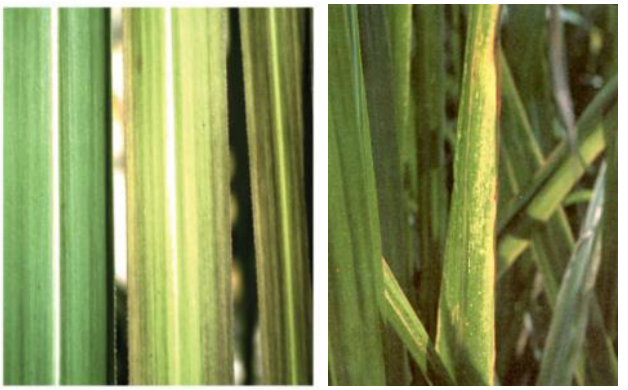
Information Sheet

7.6 Sulphur management

Sulphur (S) is an essential nutrient, with sugarcane uptake ranging from 0.2 to 0.3 kg S/tc (or 20 to 30 kg S/ha for a 100 tc/ha crop). Sulphur is required for chlorophyll formation, photosynthesis and plant growth and plays a key role in cell chemistry. Several enzymes and proteins contain S. It is similar to nitrogen in that it has a strong association with soil organic matter and microbial turnover, and thus is subject to similar processes that affect its availability. It is only taken up by plants in the sulphate (SO_4^{2-}) form, which is the predominant mineral form of the element in the soil. This element has low binding capacity to soil minerals and is thus prone to leaching losses, particularly on sandy soils.

Deficiencies symptoms

- Young leaves exhibit deficiency symptoms before older leaves.
- Young leaves are light green to yellowish (similar to nitrogen (N) deficiency).
- In severe cases leaves develop a purplish margin.
- Chlorosis spreads to most of the leaves but without die-back from the tips (as with N deficiency) and leaf edges become necrotic.
- Stalks and leaves are very thin.



▲ Sulphur deficiency often appears similar to N deficiency. In severe cases a purple colour develops on leaf edges.

Impact of excess sulphur

Evidence for excess S is limited and usually associated with acid sulphate soils, where other growth constraints limit production. These soils are very rare in the local sugar industry, but may occur where wetlands are drained for cultivation. It may also occur where excess amounts of elemental S or sulphide compounds are applied (but this is unlikely).

Factors affecting sulphur supply

There are two main loss pathways for S which are gaseous losses and leaching losses.

Gaseous losses

In poorly aerated soils, sulphate can be converted by soil bacteria to hydrogen sulphide (a toxic gas that has a rotten-egg smell) or sulphur dioxide, which can be lost to the atmosphere. This is more common in soils that easily saturate and do not drain (heavy clays, compacted soils, low lying soils that accumulate water, inter-row puddling) and may be of particular concern where there is over-irrigation and when flood-irrigation is used. Sulphur is also lost during burning of sugarcane.

Leaching losses

Sulphate does not interact strongly with soil particles and will readily move through a soil, especially if the soil is free draining. This effect tends to be greater in sandy and low organic matter soils with low nutrient holding capacity and high free drainage.

Immobilisation and mineralisation

Like N, most of the S in a soil exists in the organic form (up to 90% in most soils where no fertiliser is recently applied). This is the main reason why high organic matter soils (i.e. N-category 3 and 4 soils) require less sulphur than low N-category soils. Soil micro-organisms are principally responsible for releasing S into the soil from the breakdown of organic matter (**mineralisation**). Assimilation of S by microorganisms is a less dominant process so typically does not result in the lock-up as observed in nitrogen.

Sulphur recommendations

Sulphur recommendations consider the organic matter status of the soil and soil test value. Soils with high organic matter tend to have better S supply than low organic matter soils. Thus sandy soils with low organic matter are more likely to require and respond to S fertilisation. Four categories, as used for N mineralisation potential, are also used for guiding sulphur requirements.

The soil test for S is based on the same anion exchange resin method used for phosphorus determination. The test measures readily available sulphate in the soil and provides an indication of the immediate supply of S from the crop. A threshold of **15 mg/L** is used to assess adequacy of soil supply. The table on page 3 serves as a general guideline to adjust S application rates.

▲ Regularly soil sample your soils to determine S availability. The FAS Agricultural Laboratory offers this test as part of their routine soils package.

Sulphur recommendations based on soil test values and soil nitrogen (N) category

Soil N category		1	2	3	4
S supply from organic matter		Low	Moderate	High	Very High
Response expected		Likely, except where soil test values are high	Possibly where soil test values are marginal	Unlikely except where leaf test values indicate deficiency and soil test is low	Not likely, though readily available S may be low – use soil test and leaf testing to evaluate uptake
Soil test value (mg/L)	Approximate amount of S in soil (kg/ha)	Amount S to apply (Kg/ha)			
<5	<10	30	25	20	15
5 - 10	10 - 20	25	20	15	10
10 -15	20 - 30	20	15	10	5
15 - 20	30 - 40	10	5	0	0
>20	>40	0	0	0	0

Gypsum is perhaps the most cost-effective and simple product to apply. Gypsum contains between 15 and 18% S (as well as calcium (Ca)) and 100 kg of gypsum will supply 15 to 18 kg of S. For practical application reasons, gypsum rates of 500 to 1000 kg/ha (about 75 to 150 kg S/ha) are generally advised, this being suficient to supply S for several seasons. This can be broadcast applied in both plant and ratoon cane and can be incorporated with other fertilisers during land preparation in a replant cycle. Where furrow or banded application is preferred, lower rates of gypsum (250 to 500 kg/ha) can be used. Use of other S containing fertilisers will supply varying amounts of S which can be determined by their sulphur concentration and application rate. Ammonium sulphate is perhaps the most common, though it has a strong soil acidifying effect.

In sandy soils, more regular soil testing for S levels is required (and advised) due to the higher risk of leaching losses. Leaf testing is a useful tool to evaluate if adequate S is being taken up by the crop. A threshold value of 0.12% is used to determine adequacy levels, while a N:S ratio of 17 can also be used to determine if there is a satisfactory balance between N and S. This can be undertaken in the growing period after S application.

Available sulphur fertiliser product formulations

Source/product	S %	Other %	Notes
Gypsum ($CaSO_4$)	12-18	Ca:16-19	Suitable for of all soil types but may require additional Mg when applied to sandy soils.
Ammonium sulphate	23	N:21	Typically used as N fertiliser when S is required. Strongly acidifying.
Ammonium sulphate nitrate (ASN)	13	N:23	
Single super phosphate (SSP)	10	P:8-11 Ca:20-22	Typically used as P fertiliser but supplies S and Ca.
Epsom salt (magnesium sulphate)	12.4	Mg:9.6	Not most cost effective, but may be useful when Mg is needed.
Potassium magnesium sulphate	22	K:11 Mg:11	Not most cost effective, but may be useful when Mg and K are needed.
Elemental S	90 - 100		Strongly acidifying and dificult to handle and becomes corrosive. Typically used to acidify alkaline soils to increase P and micronutrient availability. Furrow application is mostly advised.

Louis Titshall (Senior Soil Scientist)

October 2022