PDA NEWS

March 2025

Introduction

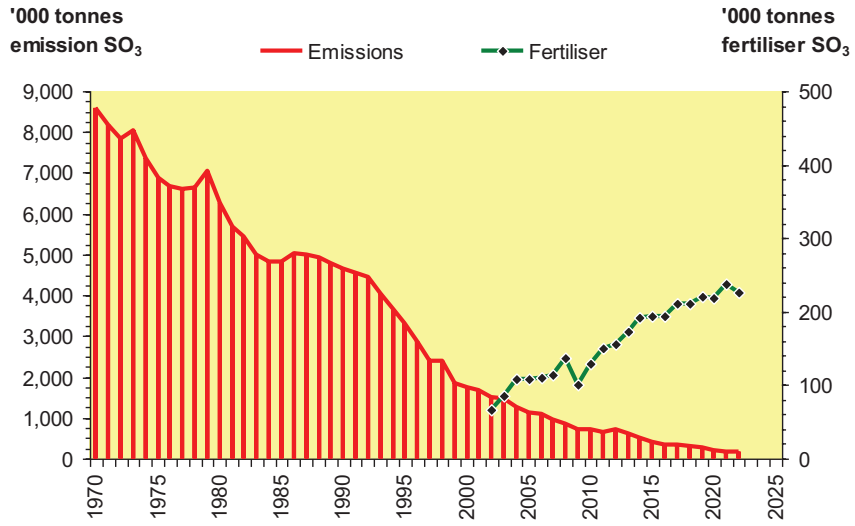
Sulphur is an essential nutrient for all plants and animals, but as its behaviour in the soil is very similar to that of nitrogen, high rainfall can lead to leaching. This could lead to sulphur deficiencies despite attempts to avoid this. Sulphur is known to be important for yield and quality, however there is strengthening evidence to suggest that sulphur has an important relationship with a large number of other nutrients. Ensuring an adequate supply through the growing season could be key to ensuring these other nutrients are taken up efficiently also.

Sulphur

Sulphur is an essential nutrient for all plants and animals, with some crops more vulnerable to deficiency than others. It should be relatively common knowledge that historically, in the UK, sulphur was deposited on land from the atmosphere in (more than) adequate quantities for optimal growth and development. However, as the burning of UK coal (high S) in power stations was switched to imported coal (low S) and natural gas, aerial deposition declined dramatically. This continued when emissions regulations forced flue gas desulphurisation units to be fitted, and now very little lands on our fields. As recently as 30 years ago there was as much as 130kg/ha of sulphur deposited in the UK, however it is now estimated that this figure could be as low as 1-3kg/ha over the year. As a result of this reduction, soils are now showing critical signs of sulphur deficiency and applications of sulphur to crops has become an essential part of Nutrient Management Planning on farms.

The graph below shows this reduction in emissions from the 1970s (as SO_3) with very little being measured from 2015 onwards, together with the compensatory input of fertiliser sulphur.

Figure 1: *Anthropogenic emissions of sulphur and the quantity of fertiliser sulphur used in the UK, as kt of SO_3.*



This deficiency has been confirmed through trial work, where the high yield responses first seen on the light sandy soils at Woburn, have become more apparent elsewhere, including heavy clay soils. With the weight of information available to support the justification for the use of sulphur and the relatively low cost of the input, it stands to reason that most growers would have this covered. Figure 1 also shows that as the emissions dropped, the annual use of sulphur-containing fertilisers rose to counteract this, but this does not necessarily confirm that sufficient was being done to fully correct the deficiency. Indeed, recent evidence from sampling by NRM suggests there is room for improvement on this front.

Sulphur in the soil behaves in a similar way to nitrogen. It becomes plant-available from the breakdown of organic matter, and to some extent from soil minerals. Soils which are organic, or heavy textured are more able to supply sulphur than light and inorganic soils.

Plants take up sulphur in the form of the sulphate anion (SO_4^{2-}). These sulphate ions predominate in the soil solution which means they are at risk of leaching, depending on the soil texture and rainfall, just like nitrate. This risk must be taken into account when nutrient planning.

Immediately available sulphur in the soil can be measured by lab analysis, but its variability both down and across the soil profile and over time, means that the normal 4 yearly soil analysis (for pH, P, K & Mg) is not appropriate. Both the organic processes and the leaching potential cause levels to vary by month, and by year.

Whilst on an individual level there may be limited merit in sampling soil, there can still be value in looking at the averages, particularly across seasons. Lancrop Laboratories data (Figure 2) shows that whilst there is some fluctuation on an annual basis, there has been an increasing trend of deficiencies identified in soils over the last few decades. One of the reasons for the fluctuations, which may prove very relevant for future sulphur management strategies, could relate to seasonal weather conditions.

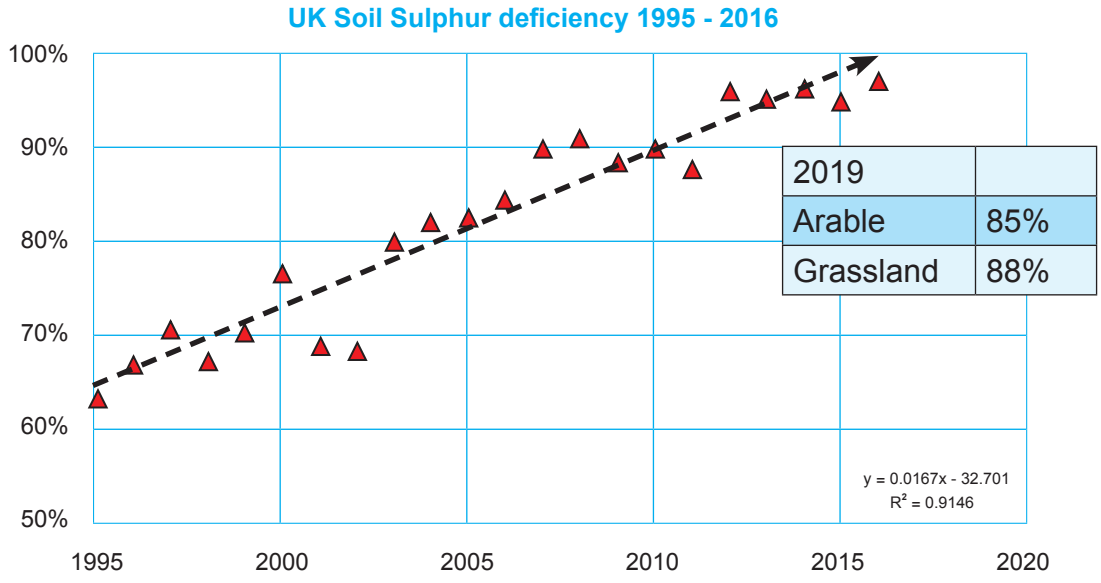


Figure 2: *Deficiencies of available soil sulphur as measured by soil analysis, 1995-2016 (Source: Lancrop Laboratories).*

The variable nature of the spring weather over the last few seasons has led to some interesting findings from tissue samples sent into NRM over the last few years. Looking at spring 2021-2023 we have had a dry, average and wet spring. In these years sulphur levels were seen to be lower in both the wet and dry spring, with the more 'average' spring resulting in higher tissue sulphur levels in plants. Interestingly, when looking at the national average yields and the leaf nitrogen concentrations for the corresponding years, the lowest yields were in the season which had the lowest nitrogen and sulphur concentrations, whilst the highest yields came in the year that both nitrogen and sulphur levels were recorded highest. Whilst there is no direct link due to the lack of yield data for the samples sent, this does perhaps indicate a relationship.

What is possibly of greater interest from the dataset is where NRM have looked at the correlation between different nutrients. This has shown that sulphur appears to have a strong positive correlation between the greatest number of other nutrients, notably nitrogen, phosphorus, potassium, magnesium and zinc (Figure 3). Although it does not definitively indicate which nutrient is responsible for the correlation, this would suggest that sulphur is having a positive impact on the uptake of these other nutrients.

Nutrients	N	P	K	Mg	Mn	Cu	Fe	Zn	B	S
Nitrogen (N)	1.00									
Phosphorus (P)	0.63	1.00								
Potassium (K)	0.49	0.59	1.00							
Magnesium (Mg)	0.28	0.23	-0.17	1.00						
Manganese (Mn)	0.12	0.11	-0.01	0.16	1.00					
Copper (Cu)	0.23	0.11	0.06	0.13	0.22	1.00				
Iron (Fe)	0.00	0.04	0.05	0.17	0.31	0.10	1.00			
Zink (Zn)	0.29	0.26	0.16	0.18	0.11	0.23	0.12	1.00		
Boron (B)	0.17	0.09	-0.16	0.44	0.20	0.15	0.19	0.18	1.00	
Sulphur (S)	0.79	0.55	0.37	0.32	0.16	0.19	0.03	0.32	0.27	1.00

Figure 3: *Pairwise Correlation Matrix, showing correlations between different pairs of nutrients from tissue analysis (Source: NRM).*

It is not surprising to see such a positive correlation between sulphur and nitrogen, as this has been well understood for some time. Sulphur is essential for protein synthesis, to maintain the balance of amino and sulphur-containing compounds. Due to the central role of both sulphur and nitrogen in the synthesis of proteins, the supplies of these nutrients in plants are highly inter-related and a shortage in the availability of sulphur will reduce the efficiency of nitrogen use.

As well as protein synthesis sulphur is essential for plants to form enzymes, vitamins, and chlorophyll. In legumes, it is crucial in nodule development and efficient nitrogen fixation and is critical for determining the nutritional quality of foods.

This is not the first time this sort of correlation has been seen; trials have been carried out by ICL using autumn applied sulphur in winter barley. In a series of 6 trials Polysulphate was applied at 100kg/ha at drilling with some areas left as a control. On average across the sites there was unsurprisingly an increase in sulphur where it had been applied, but there was also a marked increase in nitrogen, phosphorus and potassium, despite not having applied any nitrogen or phosphate. The other nutrients that NRM identified as correlating to sulphur were not measured in this trial.

Increases in plant tissue content in December following autumn application of Polysulphate:

- Nitrogen: 27.9% increase.
- Phosphorus: 41% increase.
- Potassium: 21% increase.
- Sulphur: 21% increase.

The British Survey of Fertiliser Practice suggests that just over half of all crops are currently receiving a dressing of sulphur each year, while only a quarter of grass under 5 years old, and 10% of older grass, receives fertiliser sulphur. The importance of sulphur for the achievement of the required quality in arable crop outputs receives much attention, whereas its equal importance in ensuring the nutritional value and true protein content of grazed and ensiled grass is often overlooked. Whilst some sulphur will be supplied through organic manures as well, it is clear that a greater focus on this nutrient is still required.

It has been usual practice to apply a readily soluble source of sulphate in the early spring in the expectation that it will provide sulphur throughout the growing season. However, grain sample data from Yara (Figure 4) shows that this mobile nutrient, with its potential for being leached, does not always satisfy crop need. The chart shows that grain sulphur levels in 2024, following the extremely wet autumn, were the lowest measured over the last five years, with nearly 70% in the low or slightly low category.

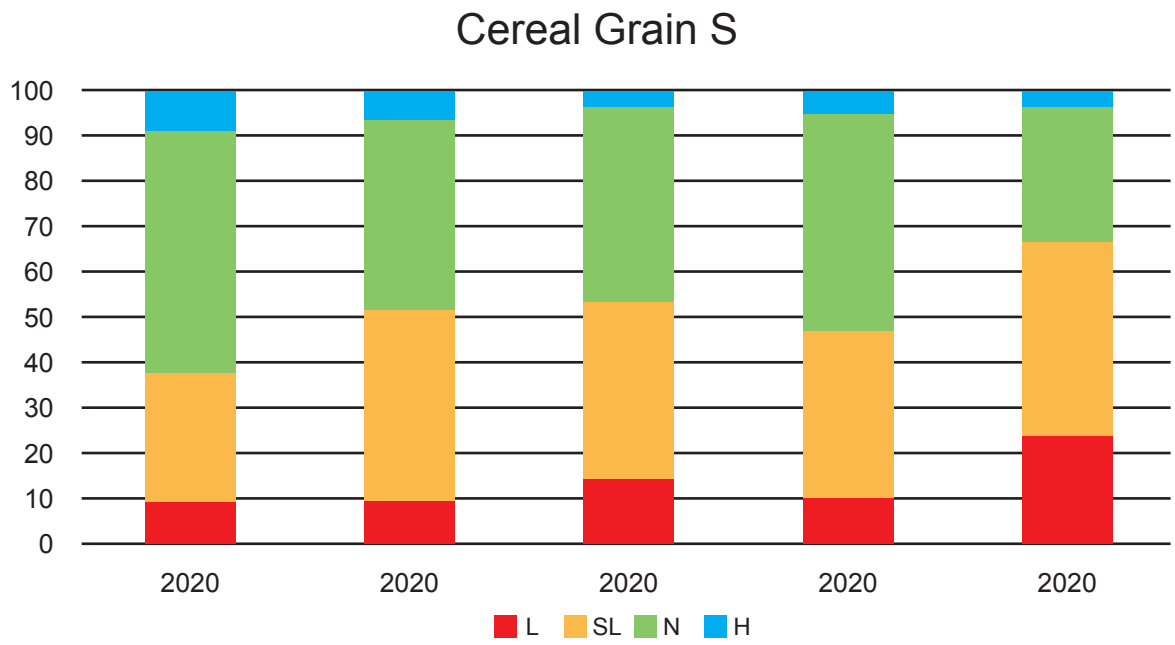


Figure 4: *Seasonal differences in cereal grain sulphur content. (Source: Yara)*

Having had another very wet autumn in 2024, sulphur is certainly one nutrient that should be high priority for this spring's nutrient management planning, to ensure not only that the supply is adequate to match the available nitrogen for these nutrients to synthesise the protein required, but that it will continue to supply sulphur throughout the growing season and not be lost by leaching.

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