Sulphur sources

Going solo

While most arable growers appreciate the pros and cons of different nitrogen sources, the same thinking isn't always applied to sulphur. *CPM* investigates the productivity and environmental implications of current sulphur options.

By Rob Jones

Sulphur is being increasingly perceived as one of the most important elements in sustainable crop production — essential in optimising NUE, plant health and grain quality.

But confusion regarding the amount of sulphur in organic sources, the potential environmental implications of its use and the efficiency with which different forms are taken up by crops, can result in many growers missing out on the opportunities sulphur provides.

According to Origin Fertilisers' technical director Peter Scott, greater understanding of the different types of sulphur available and the role they play in crop production is essential if growers are to achieve the most from it. "Sulphur is a life-essential nutrient for plants and animals and is required for protein formation, physiological functions including photosynthesis, and formation of oils, glucosinolates, hair and wool."

Critical sulphate

"Most major crops, including grass, require large amounts of sulphur in the form of sulphate," he explains. "Sulphate is negatively charged which means it isn't held on the exchange sites in soil clay and organic matter particles, so is easily leached, particularly from light soils and in high rainfall conditions."

Peter says despite its fundamental importance, he believes agriculture still doesn't give sufficient attention to sulphur nutrition in terms of how much, when and in what form. "This is reflected in the lack of detailed recommendations in RB209, but there's an urgent requirement to increase our knowledge of sulphur nutrition both individually and collectively, to improve on-farm practice," he stresses.

ICL Growing Solutions agronomist Scott Garnett agrees — he says latest soil testing by Lancrop Laboratories shows some 97% of UK soils are deficient in sulphur.

"While atmospheric sulphur was once abundant, control of pollution by heavy industry and other practices over recent years has now reduced this significantly, so growers have to include supplementary sulphur in crop nutrition.

> *"There's an urgent requirement to increase our knowledge of sulphur nutrition both individually and collectively, to improve on-farm practice."*

"Organic sources such as FYM and slurry contain very little usable sulphur, so without an efficient source of additional sulphur, nitrogen can not only be under-utilised leading to poor crop production, it can be lost to the atmosphere or leached from the soil causing potential environmental issues," he explains.

Professor David Powlson, emeritus scientist at Rothamsted Research and joint author of a recent review looking at the environmental implications of sulphur use, says there's much to be gained from applying sulphur separately from nitrogen.

"In recent years ammonium sulphate (AS), alone or with other nitrogen fertilisers, has accounted for the majority of sulphur applications made in the UK and has ▸

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Sulphur sources

According to Peter Scott, greater understanding of the types of sulphur and the role they play in crop production is essential if growers are to achieve the most from it.

▸ become the standard sulphur fertiliser source.

Emissions concerns

"However, AS fertiliser is subject to ammonia volatilisation in soils with a pH of 6.5 or above, which account for more than 60% of the UK's arable soils. This loss of nitrogen as ammonia, which is as great as with uninhibited urea on high pH soils, has received hardly any attention despite concerns regarding ammonia emissions and efforts to improve NUE," continues David.

The review found ammonia losses of up to 66% from AS on soils with a pH of 7.0 and above, with soils above pH 6.5 also at risk, he points out.

"Based on the fact 40% of UK arable soils are at or above pH 7.0, and 21% are between 6.5 and 7.0, this means replacing AS with a different source of sulphur could decrease ammonia emissions related to sulphur fertiliser applications by 90%.

"This includes taking into account the likely emissions from the alternative nitrogen source required to replace the nitrogen in the AS," explains David.

He says AS is a cheap source of sulphur because it's a by-product from other industries. "We appear to have overlooked the fact that it has ammonia in it which can be lost and contribute to emissions. People tend to think all sulphur sources are the same, and they are not," he stresses.

Essex arable producer George Halsall of E. Halsall and sons Ltd, Langham, says sulphur has long been an important part of the farm's crop nutrition strategy, but a recent move to separate nitrogen from sulphur application is delivering notable benefits.

With a diverse rotation including potatoes, wheat, winter and spring barley, ▸

Sulphur sources pros and cons

Ammonium sulphate (21% N; 60% SO3)
Ammonium sulphate (AS) is long established as the main sulphur source in the UK and is widely available as a 'straight' and also within nitrogen sulphur (NS) compounds and nitrogen, phosphate, potassium and sulphur (NPKS) blends, explains Origin Fertilisers' Peter Scott.

"AS provides rapid dissolution giving immediate release with the nitrogen and sulphur working together, which can be beneficial. All ammonium sulphate contains N so sulphur can't be applied in isolation which reduces agronomic options and also increases CO2e of the product."

According to Peter, there's also a risk of ammonia volatilisation when applied to calcareous, high pH soils, as well as AS products not being suitable for organic farming.

"The rapid release of nutrients can result in leaching of both N and S in light soils and areas of high rainfall and, as AS contains ammonium-N, it is also highly acidifying to the soil.

"If you want to spread to 36m, you'll also have to make sure you choose the highest quality granules available," he advises.

Polysulphate (48% SO3, 14% K20, 17% CaO, 6% MgO)
UK-produced Polysulphate offers sustained release nutrients during a period of around 50 days to match crop requirements and deliver potential environmental benefits, continues Peter.

"This mode of operation reduces the risk of sulphate leaching in light soils or in high rainfall considerably compared to AS, plus it means you can apply a full season's sulphur in a single, early application to reduce workloads.

"As Polysulphate doesn't contain N, it also means the best sulphur strategy can be planned separately from nitrogen, which gives greater agronomic flexibility."

Peter says Polysulphate is a multi-nutrient fertiliser which provides potash as well as calcium and magnesium in water-soluble forms which is important. "By providing water-soluble forms of four essential nutrients, Polysulphate offers growers good value for money."

Kieserite – magnesium sulphate (25% MgO, 50% SO3)
Kieserite is another imported sulphur source for UK growers but is really only appropriate when magnesium is required, highlights Peter.

"While it's another natural mineral with a low carbon footprint like Polysulphate, it doesn't have the prolonged release, so rapid dissolution of its water soluble sulphate can cause leaching risks in light soils and areas of high rainfall

"The cost point per Kg of S is higher than with AS, so unless you're in a highly magnesium deficient situation, it's difficult to see its advantages for mainstream growers," suggests Peter.

Gypsum – calcium sulphate (32% CaO, 46% SO3)
Peter believes although it's a source of sulphate, there are few specific advantages of Gypsum over the other listed options. "It has low solubility so isn't really an ideal source of either calcium or sulphur.

"A lot is said about gypsum being used to alter the Ca:Mg ratio in the soil and improve soil structure, but there's little science available to support this theory," he says.

UK-produced Polysulphate offers sustained release nutrients during a period of around 50 days.

Elemental sulphur – 225-237.5% SO3 (90-95% S)
Elemental sulphur is a highly concentrated source of S and the only product that contains S with no other nutrients, continues Peter.

"That said, sulphur in the elemental form isn't available for crop uptake as it must be oxidised into sulphate within the soil which takes time with no control over when the nutrient will be available to the crop.

"Soil bacteria can also react with elemental sulphur to produce sulphuric acid which can acidify soil," he concludes.

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Scott Garnett says increasing numbers of UK growers are now realising the benefits of decoupling nitrogen and sulphur applications.

▸ sugar beet and onions, plus a beef suckler herd to manage, flexibility of operations is a key element of the business' management approach.

"We're looking at ways we can build more sustainable production methods into our operations but always have an eye on the costs involved. No business is sustainable if it doesn't make money so there's definitely a balance to achieve.

"Reducing inputs and improving NUE are key drivers for us, but we're also looking at biosolutions to make our fungicide use more effective, for example, and growing cover crops to improve the soil."

George says the role of sulphur in the 'nitrogen equation' is well understood, as is its requirement for boosting grain protein, particularly in light of the farm introducing milling wheat.

"AS true granular compounds — both 27N + 30SO_3 and 27N + 12SO_3 — were used for many years but they were always a little restrictive. This is because whenever we wanted to apply sulphur, we were applying nitrogen and the ratios were fixed, so the plan was rigid.

"There were times when if we wanted to change the nitrogen rate, for example, we would also be changing the sulphur rate, leading to either applying too much of one or having to top up with an extra pass of N. When nitrogen fertiliser prices hit £1000/t, the cost of the nitrogen sulphur compounds increased too, so we decided it was time to take a look at the alternatives," he explains.

According to George, Polysulphate turned out to be a cost-effective option which appealed because it could be applied separately from the nitrogen, allowing him to take a more field-by-field approach.

"It's simplified our nutrition management so we can now meet the different nutrient demands of the various crops we grow. The fact it's a prolonged release product also appeals as it means we can reduce workloads by putting on one application at the start of the season and the sulphur is then available as the crop grows during the next couple of months or so."

Polysulphate use

As a result, Polysulphate has been used for four years. "Our wheat, barley, sugar beet and silage crops all get 100kg/ha of Polysulphate at the start of the season to provide 48kg SO3/ha, with inhibited urea usually applied in 2-4 splits to complement this, ranging from a total of 240kgN/ha for our Crusoe wheat to 90kgN/ha for the spring barley.

"The fact it contains potash, magnesium and calcium are also benefits over other sulphur sources, and its ability to spread evenly at 24m has also impressed," says George.

ICL's Scott Garnett says increasing numbers of UK growers are now realising the benefits of decoupling nitrogen and sulphur applications, with Polysulphate gaining in popularity.

"It's a naturally occurring multi-nutrient fertiliser with an analysis of 48% SO_3, 14% K_2O, 17% CaO and 6% MgO, so growers can select low emission sources of nitrogen to apply with it, rather than having N and S locked together.

"This allows for a flexible approach with a much-reduced environmental impact and

The sulphur provided by Polysulphate is in a readily available form unlike elemental sulphur which can't be taken up by plants.

Polysulphate's prolonged release ensures nutrient availability is matched to crop requirements through the growing cycle, says Scott Garnett.

significantly increased levels of efficiency. In fact, the NUE improvement from using Polysulphate leads to significant increases in yield and quality — this has been shown in numerous trials with yield uplifts of more than 8-12% in winter wheat and as much as 33% in oilseed rape, compared with the commonly used NS products."

Furthermore, Scott says in leguminous crops which rely on nitrogen fixed from the air, the addition of Polysulphate has been shown to increase yields by up to 40%. "Trials in vining peas, for example, have shown 75kg/ha of SO3 applied as 150kg/ha of Polysulphate produces 1t/ha extra yield of peas."

Mined from under the North Sea in Yorkshire, Polysulphate's formulation and physical form has much to do with the benefits observed, he says. "University of Nottingham trials looking at soil leaching of nutrients have shown more than 50% of the sulphur contained in Polysulphate is released in the first 10 days after application, with the remainder available to plants during the following 6-8 weeks.

"This prolonged release ensures nutrient availability is matched to crop requirements through the growing cycle which is in contrast to traditional AS, where 100% of the sulphate is released within 5-6 days after application,"

According to Scott, the sulphur provided by Polysulphate is also in a readily available form unlike elemental sulphur which can't be taken up by plants. "Polysulphate, therefore, not only increases the efficiency of key nutrient uptake to maximise crop productivity, it also reduces the possibility of soil nutrient loss and resulting environmental consequences," he concludes. ■