



techtalk

Improving nutrient use efficiency

ICL UK operates the world's only Polyhalite mine in Boulby, North Yorks. Since 2012 polyhalite, brand name Polysulphate, has offered farmers balanced, efficient and sustainable crop nutrients.

ICL is committed to help farmers optimise crop production and quality in a more environmentally sustainable way.



Making the most of nutrients

Sulphur can be the limiting factor in many soils when it comes to plant growth and nutrient uptake. Autumn-applied Polysulphate could help crop plants become more efficient. CPM finds out more.

By Lucy de la Pasture

When the NFU set out the three pillars which will support agriculture's move towards becoming net zero goal by 2040, it signalled an acceleration in change.

At the core of the strategy to reduce greenhouse gas emissions (GhG) is to improve farming's productive efficiency — enabling farming to produce the same quantity of food, or more, with less inputs in smarter ways.

Fertilisers are one of the major contributors to GhG emissions and some of these 'smarter' ways include the use of controlled or prolonged release technologies, precision nutrition and a heightened focus on soil problems which may interfere with nutrient uptake, such as compaction.

At the heart of a smart approach is understanding nutrient

use efficiency. How different forms of fertiliser affect how efficiently plants can make use of them is an important part of increasing productive efficiency. ICL's Scott Garnett explains why a focus on balanced nutrition is important.

Why is nutrient use efficiency so important?

Often plant nutrients are considered in isolation but are in fact dynamic and can influence the availability of other nutrients in the soil. According to Liebig's Law of Minimum, growth is dictated not by total resources available, but by the scarcest resource (limiting factor). Unless the crop has access to balanced nutrition then it will never fulfil its genetic potential.

Very often sulphur is now the limiting factor in UK soils, highlighted in a recent study by

Lancrop Laboratories in 2019 which revealed 85% of arable soils and 88% of grassland soils are sulphur deficient in the UK. Even so, sulphur is often the forgotten nutrient because it used to be free — brought down from the atmosphere by rainfall and deposited onto soils.


One of the ways of improving the nutrient use efficiency of crops in the autumn is to apply Polysulphate — 48% SO_3 as sulphate; 14% K_2O as sulphate of potash; 6% MgO as magnesium sulphate; and 17% Ca as calcium sulphate. Trials have shown that where Polysulphate is applied, there's an increase in nitrogen and phosphate uptake, as well as an uplift for other essential nutrients.

What is the role of sulphur?

Sulphur is one of the 17 essential nutrients and has some key functions in plants. One of these is in the formation of chlorophyll for photosynthesis, the means by which plants produce starch, sugars, oils, fats, vitamins and other compounds.

Sulphur is a constituent of three sulphur-containing amino acids (cysteine, cystine and methionine), which are the building blocks of protein. About 90% of plant sulphur is present in these amino acids.

Another important role of sulphur is in the activation of



“Growth is dictated not by total resources available, but by the scarcest resource.”

enzymes, which aid the biochemical reactions in the plant. All of these help increase crop yields and quality — sulphur improves protein and oil percentage in seeds and grains. If insufficient sulphur is available, then free amino acids are produced which when heated can be converted to acrylamides — undesirable in bread making processes and when frying potatoes. By ensuring adequate sulphur is available then it reduces the possibility of free amino acids occurring in plants.



Scott Garnett says one of the ways of improving the nutrient use efficiency of crops in the autumn is to apply Polysulphate.

How does Polysulphate help?

Polysulphate contains four of the major plant nutrients — sulphur, potassium, magnesium and calcium — all essential for plant growth and development and quality. But as well as supplying the crop with essential nutrition, it is also made from a sustainable resource — mined in Boulby in North Yorkshire.

It's low carbon footprint makes Polysulphate unique among fertilisers, as well as being organic and environmentally friendly. Because it's a ground rock, the nutrients held within the rock crystals are released over a prolonged period. Nutrients are released over 50 days, so the plants can take up more of the available nutrients over time.

Polysulphate provides an available source of sulphur which doesn't contain nitrogen, so it provides an opportunity to apply sulphur separately from nitrogen — which is particularly useful at times when nitrogen cannot be applied. This added flexibility opens the door to autumn applications when sulphur can play a key role in establishment and nutrient uptake efficiency.

Why apply sulphur in the autumn?

Autumn soils are still warm and packed with mineralized nutrients, including nitrogen, which could be taken up by crop roots rather than

leached out of the rooting zone — one of the rationales of cover cropping is to mop up these nutrients and prevent them from being leached.

Sulphur deposition from the atmosphere has decreased from 130kg SO₂/ha 30 years ago to approximately 1-5kg SO₂/ha in the present day. Sulphur is also mobile in the soil so, in all likelihood, the levels present limit the uptake of the available nitrogen present in the soil, according to Liebig's Law. Applying small amounts of sulphur in the autumn in the form Polysulphate (100kg/ha applies 50kg SO₂/ha) helps young crop plants take up the mineralized nitrogen available in the soil.

But it's not all about nitrogen uptake. The importance of phosphate on rooting is well established, even on soils with a high P index crops benefit from some fresh phosphate at planting (as it's not mobile). Trial results have shown an increase in root biomass of 30-40% where Polysulphate has been applied. A larger root mass provides a greater surface area of roots in contact with the soil and this increased root biomass provides more opportunity to scavenge nutrients — another contribution to improved nutrient use efficiency from autumn application. And the same is true in spring, the fresh potash brings with it an added benefit.

Better rooting systems will also

result in stronger and healthier plants in the spring. It's been noted in oilseed rape trials that senescence of the older leaves in spring doesn't occur where Polysulphate was applied the previous autumn and it appears to give the crop added winter hardiness, allowing plants to take early and full advantage of nutrients in the spring.

Another benefit from maintaining nutritional balance is that it makes plants more resilient to abiotic stress and disease. Potassium and calcium both have roles in plant defence systems — particularly maintaining the strength of cell walls — so reinforce the plant's natural mechanisms to fend off disease.

What do the trials say?

In 2021, ICL looked at nutrient use efficiency in winter barley trials. Over six sites, application of 100kg/ha Polysulphate in autumn improved nitrogen uptake by an average of 27.88% (average extra 6.52kgN/ha); improved carbon uptake by 15% (40kg C/ha); sulphur and potassium uptake by 21% and phosphate by 41% — reinforcing the importance adequate available sulphur has on improving nutrient use efficiency.

This improved uptake and increased root biomass has also been shown to translate into yield responses in further trials on both oilseed rape and winter wheat. In OSR establishment trials in 2019,



Polysulphate application has been shown to increase root biomass in trials, improving nutrient use efficiency.

autumn applications of Polysulphate were compared with the standard farm practice of DAP, applied as a starter fertiliser, and spring applied ammonium sulphate. Two different rates of Polysulphate (100kg/ha and ►

Top tips – Improving nutrient use efficiency

- **Apply 100kg/ha Polysulphate in autumn** — trials show enhanced uptake of other nutrients, including nitrogen and phosphate, where applied.
- **Benefit from prolonged release** — nutrients are released slowly as the rock crystals dissolve so more fertiliser is taken up by the crop and less leached into water.
- **Take the opportunity to get S and K on in early spring** — then you can follow the weather applying early without having to apply nitrogen.

Autumn sulphur the new norm

Paul Hogarth's 80ha farm is situated on the North Yorkshire coast near Whitby, around 12 miles south of the ICL mine at Boulby. In spite of his proximity to the world's only polyhalite mine, the source material for Polysulphate fertiliser, last season was the first time he'd applied it to his OSR crop.

The farm is mostly arable with a rotation of OSR, winter wheat and traditionally winter barley, but spring barley this time around after wet last autumn put the kybosh on plans to drill winter barley, explains Paul. He also buys calves and rears them on, grazing on his grassland before

selling as store cattle.

Last year's OSR crop established well after drilling on 14 August, with little trouble from cabbage stem flea beetle. "We use a min-till system, drilled and rolled well afterwards, so moisture was conserved.

"We usually apply 250kg/ha 0-20-20 as a base fertiliser in autumn but this time also applied 150kg/ha of Polysulphate, which we repeated in the spring. The crop really took off and formed a strong root system, with a 15-20% increase in root mass," he notes.

Paul also believes the addition of

Polysulphate seemed to help with drainage on his land and he noticed improved winter hardiness in a spring that was memorable for its frosts. But the proof of the pudding is in the eating so how did his crop perform at harvest?

"Where we applied Polysulphate we've seen tremendous yields for us, much higher than the farm average and 13% higher than non-treated. I haven't sold it yet so I haven't got the oil content, but the sample looks good and bold, with very few red seeds," he says.

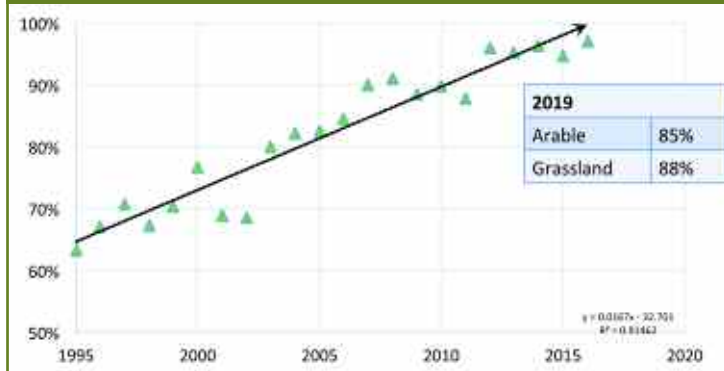
Previously Paul has always applied sulphur to his crops as ammonium sulphate in spring — autumn sulphur



Autumn polysulphate application improved OSR root biomass by 15-20% at Paul Hogarth's farm.

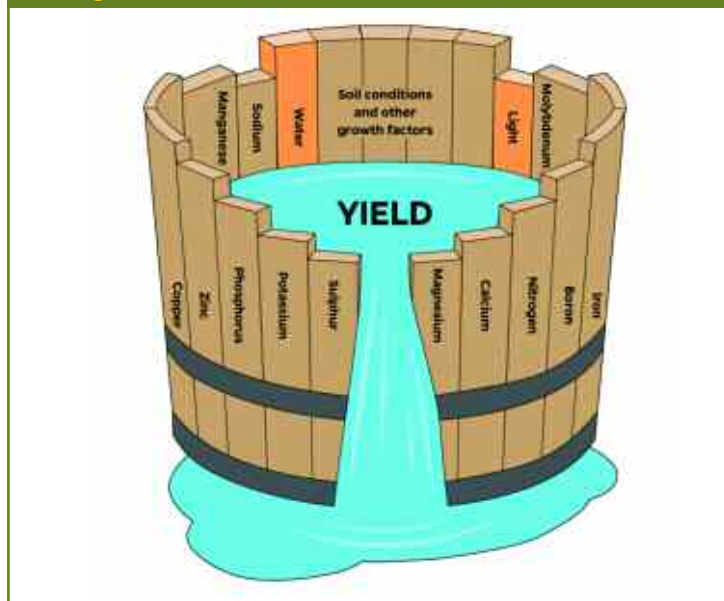
application wasn't an option because of the nitrogen content of the fertiliser. Polysulphate makes autumn application possible and his newly planted OSR crop, drilled on 4 August, will benefit from the new fertiliser regime.

UK soil sulphur deficiency 1995 - 2016



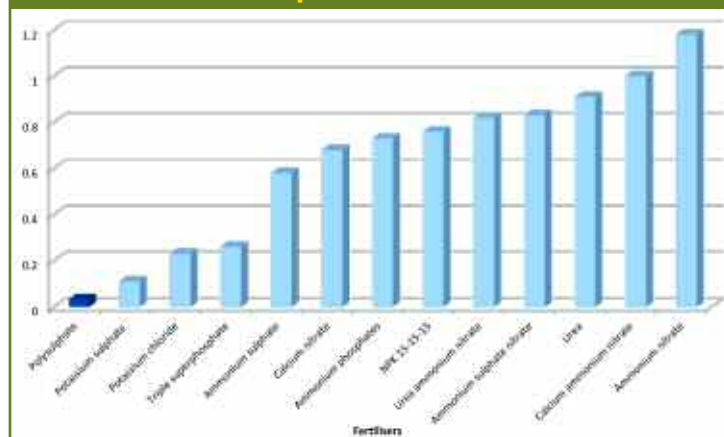
Source: Lancrop Laboratories, 2019

Liebig's Law of Minimum



Liebig's Law of Minimum states that growth is dictated not by total resources available, but by the scarcest resource (limiting factor).

Fertiliser carbon footprints



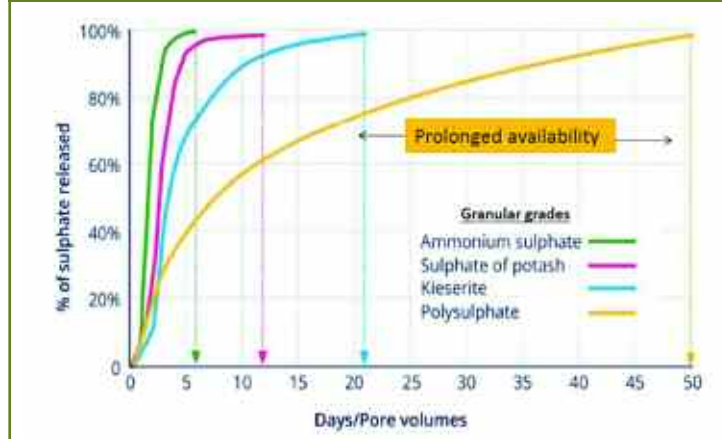
Polysulphate has a very low carbon footprint (0.034 kg CO2e/kg) compared with other fertiliser types.

► 150kg/ha) were applied in addition to the base DAP in a split field trial on a medium loam soil in North Yorkshire. The treatments were taken to yield and the lower rate of Polysulphate resulted in a 7% yield increase and the

150kg/ha rate produced a 19% increase over the standard farm practice.

In 2018 the effect of Polysulphate as an autumn application to winter wheat was investigated in a split field trials

Release of sulphate



Polysulphate versus other granular sources.

Source: Jiang et al. (2016). Dissolution Rate of Selected Sulphur Fertilizers; Understanding Selenate - Sulphate Competition. In: Royal Society of Chemistry, 16. London, UK: University of Nottingham

on a sandy clay loam soil. Approximately 1.92ha received a base application of 250kg/ha 0-20-30 fertiliser, the other 1.92ha received the same base application and a further 100kg/ha Polysulphate. The trial was taken to yield and there was a 5.4% yield increase where it was applied.

Are there environmental benefits?

One of the potential advantages of autumn Polysulphate application is that it helps retain phosphate and nitrogen in the soil (by facilitating uptake by roots) so that it doesn't get into surface waters and cause pollution. ICL is looking at these effects on 10 sites in combined

research with a water company to assess whether phosphate and nitrate losses can be reduced.

A big part of current ICL research is looking at the effects of fertiliser application on soil biology. It's been established that fertilisers high in salt can have an adverse effect on soil biology, such as bacteria and fungi. Conversely if the crop produces a bigger biomass, then the extra carbon will provide food for those organisms. Polysulphate has a low salt index but it's important to understand any effects on the microbial balance in the soil, which may be positive as increases in carbon provides more food to sustain soil organisms. ■

Sponsor message

ICL UK's Polysulphate-based products, including the Fertilizerplus range, have been proven to improve soil and plant health as well as helping farmers increase productivity, quality and profits more efficiently and more sustainably.

Polysulphate is a natural multi-nutrient fertiliser containing 48% sulphur, 14% potash, 6% magnesium and 17% calcium, all in a low chloride form. A key benefit is the prolonged release of essential nutrients at a rate that is more closely matched to the crop's need as it establishes and grows. And, as a natural product, it's organically approved and environmentally friendly with the

lowest carbon footprint of any fertiliser at 0.03kg / CO₂ per kg of product.

ICL Potashplus, a compound of potash and Polysulphate (37% K₂O and 23% SO₃) plus magnesium and calcium. Has a potash: sulphur ratio that is ideally matched for most crops, satisfying potash and sulphur needs in a single application.

ICL-PKplus is a range of quality, tailor-made granulated compound products containing phosphate, potash, sulphur, calcium and magnesium (plus optional micronutrients) in each granule. PKplus can supply a crop all its non-nitrogen nutrients in a single application, it is ideally applied at planting and suitable for combined drilling.

NEW

GO-TO BIO GAS RYE

SU PLURALIS & SU ARVID Hybrid Rye

SU Pluralis and SU Arvid are new hybrid ryes with flexible end market potential for UK growers. With high-mass dry matter yields and consistently high methane content out of whole crop harvests, both are excellent choices for biogas. SU Pluralis is particularly suited to Scottish conditions with fast ear emergence a key strength. Both benefit from strong standing power and new genetics give improved brown rust resistance. When you're after new generation biogas varieties, these are the two to go to.

Ask your merchant about availability or see more at elsoms.com


Elsoms
The Seed Specialists
01775 715000 www.elsoms.com

RYE
YOU CAN
RELY ON


**SAATEN
UNION**