techtalk

Speciality fertilisers

ICL Fertilisers operates the Boulby Mine on the North Yorkshire coast, the first and only place in the world where polyhalite is extracted. This natural mineral, marketed as Polysulphate, is the base ingredient for ICL FertilizerpluS range of products offering a sustainable approach to production for UK farmers.

ICL Fertilisers

Many salts, many benefits

A unique natural mineral which is high in a number of major nutrients is being mined in the UK, yet much of it is being exported for use in agriculture worldwide. *CPM* finds out how UK farmers could benefit from using this ultra-low carbon footprint fertiliser.

By Lucy de la Pasture

> *"Polysulphate release matches the growth of the crop, meaning better nutrient-use efficiency."*

Boulby, on the North Yorks coast, is home of the UK's deepest mine. Its network of underground tunnels extends deep under the North Sea, which since 1973 has produced potash.

Earlier this decade extraction switched to another mineral source, found some 150-170m below the traditional potash deposit. The natural multi-nutrient mineral, known as polyhalite, offers an alternative source of sulphur, along with several other key essential elements.

Polysulphate has a very low carbon footprint as it's made from crushed polyhalite and no other processing is needed.

ICL agronomist Scott Garnett explains some of the benefits of using this home-produced material, which also has the lowest carbon footprint when compared with its alternatives.

What is Polysulphate?

Polyhalite was deposited around 260 million years ago. At that time, the Permian era, Europe was much further south and Boulby was situated on the edge of a broad, shallow ocean called the Zechstein Sea. The prevailing hot and dry conditions at the time meant it evaporated quicker than it could refill and the process left behind polyhalite, halite and potash minerals.

Its name, from the Greek words meaning 'many salts', reflects its composition of the hydrated sulphates of potassium, calcium and magnesium. The rock once extracted is simply crushed and bagged with no further refinement necessary before being used as a fertiliser for crops, providing a single source of sulphur, potassium, magnesium and calcium.

Why do crops need sulphur?

Two decades ago it wasn't necessary to apply sulphur to UK soils, it was rich in the atmosphere and came down in rainfall to enrich the soil, supplying approx. 85kg/ha/annum. With measures in place to improve air quality, the amount of sulphur freely available to replenish supplies in the soil has become practically non-existent, currently estimated at just 5kg/ha/annum.

This has been backed up by a recent Yara survey, which showed that more than 90% of the UK soils were at a low or critical status when their sulphur content was assessed. So to meet crop needs, sulphur needs a similar approach to nitrogen, meaning it has to be reapplied each year to ensure availability to crop plants when they most need it.

The role of sulphur in the plant's metabolism is a major one and it's essential for growth and development. Sulphur is necessary for the formation of chlorophyll that enables photosynthesis, the process by which light is

converted to energy. It's also a constituent of three S-containing amino acids (cysteine, cystine and methionine), which are the building blocks of protein. About 90% of plant S is present in these amino acids.

Sulphur is also the mineral that has a big influence on crop quality. In oilseeds, it's the key to synthesis of oils because of the part it plays in enzyme activation so adequate supply is essential to maximise the oil content of crops. In wheat for milling and baking, adequate sulphur supply reduces the amount of the free amino acids, cysteine and asparagine, in the flour which lead to the production of acrylamide during cooking, which are undesirable and can be carcinogenic.

In legumes sulphur helps in the building of root nodules as N-fixing bacteria need sulphur to take up nitrogen in the same way that plants do.

The tunnels of the mine extend deep under the North Sea and the polyhalite lies some 150-170m below traditional potash seams.

What forms of sulphur are available?

Sulphur is available in several forms for application as a fertiliser. These include as sulphates — ammonium sulphate ($(NH_4)_2SO_4$), potassium sulphate (K_2SO_4), magnesium sulphate ($MgSO_4$), calcium sulphate and Polysulphate ($K_2Ca_2Mg(SO4)_4{\cdot}2H_2O$) — as well as fertiliser products supplying sulphur in the elemental form.

Elemental sulphur has to first undergo conversion to sulphate before it's available to plant roots and, like organic manures, the speed that this occurs is down to nature so is unpredictable.

Ammonium sulphate provides simplicity for the grower as it also supplies nitrogen, making it suitable as a one-pass early spring treatment, but it does mean two different stocks of N-fertiliser have to be held on farm, with ammonium nitrate or urea required for top-up applications later in the spring.

Potassium, magnesium and calcium sulphate supply K^+ and Mg^{2+} and Ca^{2+} cations respectively in addition to the sulphur, but all have significant differences in the rate at which the sulphate is released into the soil where it becomes available for uptake by the crop.

Scott Garnett explains that the combination of sulphates in Polysulphate have a release period which matches the growth of the crop.

Ammonium sulphate is the fastest to release sulphate, so it's quickly available but also quickly lost through leaching. A PhD study at University of Nottingham found that after just three days ammonium sulphate had released all of its sulphate. Potassium sulphate took 5-6 days, magnesium sulphate was 20 days and calcium sulphate was the slowest release of all, so is ▸

Phased-release matches crop need

Peter Scott, technical director of Origin fertilisers, believes there are some very good practical reasons to consider Polysulphate as a source of sulphur for crops. It offers a very different release profile than other commonly used forms and one that better matches the growth of the crop.

"Ammonium sulphate fertilisers have a very quick release profile. Within 1-5 days of application the sulphate will have become dissolved into the soil solution, so it's very fast acting," he says.

Although this speedy release may be desirable in some circumstances, the big disadvantage is that the sulphur can be readily leached, especially in early spring if it's all applied in one lump, he points out.

"Agronomists have reported signs of sulphur deficiency in crops by April, which had received sulphur earlier in the spring. Increasingly we're seeing spells of heavy rainfall and if this happens then the sulphur in the soil solution is easily lost, especially on light and sandy soil types."

Peter believes that even when ammonium sulphate applications are split in the spring, under the right conditions and on susceptible soils it can all too easily be leached away before the crop can take it up.

"The big difference with the Polysulphate fertilisers is their release rate, which is phased over 6-7 weeks following application. The availability of the sulphur is a much better match to crop need because of this," he says.

Peter's quick to point out that while Polysulphate doesn't offer a 'better' form of sulphur as it is also a sulphate but it does offer a much better release pattern. It has a very similar cost to standard sources of sulphur but with the added benefit of water-soluble Ca, Mg and K.

"The soluble calcium is particularly important to plants because of its role in strengthening stems. In potato crops there's also a positive relationship with soluble calcium because of the part it plays in skin finish."

There's good science underpinning the benefits that have been associated with Polysulphate and Origin has drawn on a lot of independent, fully replicated trials work to back up their recommendations.

Not all sulphates are equal, says Peter Scott. Because some forms are released too quickly, sulphur deficiencies can show up later in the spring, even after application.

"The ultimate arbiter is the market and It's seen growth year on year across arable and grassland sectors. More and more growers are recognising the benefits of Polysulphate since it was first introduced a few years ago."

Speciality fertilisers: top tips

- **Match nutrients to plant need** – using soil analysis and availability of nutrients from the soil.
- **Identify limiting factors to nutrient availability** – light soils will need a sulphur form that lasts a longer time.
- **Take the opportunity to get S and K on in early spring** – then you can follow the weather without jeopardising plant growth with N applications.

A recent widescale survey has shown more than 90% of soils are sulphur deficient.

▸ largely unavailable when the crop most needs it.

In contrast, Polysulphate took 50 days for 100% release of its sulphates which matches the time taken to build the crop canopy in the spring for most crops. The way the sulphates from Polysulphate release matches the growth of the crop, meaning better nutrient-use efficiency.

What other nutrients does it apply?

Polysulphate supplies a unique cocktail of macronutrients — 48% SO_3, 14% K_2O, 6% MgO and 17% CaO in its unadulterated form, all of which are essential for the plant to grow.

Magnesium is a key building-block of chlorophyll, so is crucial for photosynthesis. Calcium is an element which is integral to the structure and maintenance of cell membranes and a lack of calcium leads to collapse and cell death, resulting in disorders, such as internal rust spot in potatoes.

Potassium acts as an enzyme regulator, so is involved in nearly all cellular functions. Water use in plants and potassium have the best-known association — it helps maintain turgor pressure, but also effects the strength of cell walls.

ICL also supply another Polysulphate product, available as PotashpluS. It's a compression product produced from the dust grades of MOP and Polysulphate (50:50) and has a faster release period of 25 days.

PotashpluS delivers 37% K_2O (part in the form of potassium sulphate and part as potassium chloride), 2.8% MgO, 23% SO_3 and 7% CaO. Both Polysulphate fertilisers supply a reduced chloride fertiliser, which is ideal for more sensitive crops such as potatoes, fruit and vegetables.

What trials work has been done?

Polysulphate products have been trialled extensively in the UK and around the world. Trials at University of Nottingham in wheat have shown increases in protein in the ear. In Ireland, trials comparing Polysulphate with other sulphur-based granular fertilisers have shown that uptake of nutrients is as good, often better.

In the USA trials in maize for AD plants have shown significant increases in dry matter which enhances the crop's value for biomass. In potatoes, improvements in amino acids have been recorded, which can help reduce the risk of acrylamide being produced when potatoes are fried, (eg for chips).

Polysulphate contains polyhalite, a natural mineral from the UK's deepest mine in North Yorks.

In peas and beans, Polysulphate has shown improved nodulation, leading to improved nitrogen-fixing capacity in the roots. For oilseed rape yield and root structure benefits have been recorded, with 30-40% more root.

In addition to replicated trials, ICL also undertakes tramline trials to give an on-farm demonstration. This season's harvest results for OSR are just coming in from the site in Suffolk and three in Yorks, where the growers average 5t/ha plus yields of OSR using autumn and spring applications of Polysulphate.

The demo trials looked at two rates of Polysulphate applied to a tramline compared with the normal farm practice and in the two trials reported to date, the lower rate of 100kg/ha Polysulphate has produced +263kg/ha and +310kg/ha more than the control treatments. That equates to an extra £92-122 of rapeseed (at £350/t), which is a significant return over the cost of around £20 for the cost of Polysulphate.

How is it best used?

Using RB209 as a guide, wheat crops require 40-50kg/ha SO_3 in spring which equates to 100kg/ha Polysulphate, which is best applied in very early spring (Jan-early Feb).

Even crops grown on soils which are relatively high in magnesium and calcium on analysis show a good response to Polysulphate application, probably due to greater root and improved establishment. Early emergence is something that has been consistently observed in trials.

In trials, crops treated with Polysulphate have consistently been observed to have bigger root systems (right).

ICL is currently investigating the use of Polysulphate in the autumn on cereals to help uptake of available residual nitrogen in the soil, minimising the risk of adverse environmental effects such as autumn leaching. The reasoning is that if sulphur levels are low in autumn soils then this may restrict the uptake of residual N. If crops were better able to make use of autumn N, then more would be taken up from soils and less leached through the winter. The work is also investigating whether there may even be an opportunity to reduce the amount of N applied in spring. ■

Sponsor message

In recent years, ICL has literally dug deep at its Boulby mine — long famous for potash production — to begin extracting high quality polyhalite from around 150m below the former potash seams.

Not only has the company extracted the mineral, but it has invested heavily in global agronomic research in order to demonstrate the added benefits from Polysulphate, a unique multi-nutrient fertiliser containing four essential plant nutrients; potash, magnesium, calcium and sulphate. All trials, undertaken by both ICL and its customers, consistently show increased quality and yield.

A key benefit of using Polysulphate is the phased release of these essential nutrients at a rate that is more closely matched to the need of the crop. And as a natural product, it's organically approved and environmentally friendly with a very low carbon footprint.

ICL's FertilizerpluS range includes Polysulphate, PotashPlus and PKpluS. All these products offer farmers multiple options for both autumn and spring fertiliser use.

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Key tips - Avadex Excel 15G

- Use all relevant IPM strategies before using the herbicide 'stack'
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- Applying on the back of the drill? Ensure the **Avadex** is being applied to a well consolidated surface and maintain a 4cm drilling depth for winter wheat.
- Applying on the back of the rolls? Is the operator PA4G certified? Make sure drilling depth is correct – 4cm for winter wheat.

Key tips - Avadex Factor

- Use all relevant IPM strategies before using the herbicide 'stack'
- Apply to well prepared moist seed beds
- Apply as part of the pre-emergence 'stack'
- Appropriate boom height, water volume, nozzle choice and forward speed

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