Understanding sulphur requirements and application options for UK arable crops

Despite longstanding evidence of the need to apply sulphur to maximise yields in many UK arable crops, latest research suggests we're still not using it enough.

Sulphur is an essential element in ensuring optimum yield and consistent quality in wheat, oilseed rape and barley. Since the late 1970s, concern over pollution and acid rain has resulted in tighter legislation that while having a beneficial effect on the environment overall, has led to a dramatic drop in sulphur available from the atmosphere. Yield potential for crops has risen at the same time as this reduction in sulphur deposition so the simple reality is that many crops are at continued risk of deficiencies connected with this vital element and are underperforming as a result.

In some crops, in particular oilseed rape, applying adequate sulphur can be the difference between having a crop to harvest or not. But even in cereals, yields can be reduced by 30-40% through lack of sulphur with a corresponding fall in quality too.

Fortunately, these losses can be simply and cost-effectively avoided by use of specially developed, sulphur-containing fertilisers but despite years of trials and practical evidence from farm studies supporting this, many UK growers are still not addressing the issue adequately.

While the British Survey of Fertiliser Practice has shown a steady increase in the proportion of arable land that receives a dressing of sulphur, analysis shows nearly 40% of winter wheat growers and almost 25% of oilseed rape producers still do not use any sulphur at all.

THE EVIDENCE FOR SULPHUR NEED

The first authority to raise the issue of sulphur deficiency as a potential concern was Rothamsted Research Station in the late 1980s, following initial evidence from Scotland that lower levels of atmospheric sulphur dioxide were reducing oilseed rape yields.

Subsequent AHDB-funded trials on the lighter soils at Rothamsted’s Woburn site revealed astonishing results, with oilseed rape yields from untreated plots being half those of crops receiving sulphur applications.

Further trials in wheat at the same Woburn location revealed a yield of just 2.5 t/ha without sulphur and 5 t/ha with appropriate applications.

Further trials went on to show an average yield benefit in responsive sites of 27%.

In milling wheats sulphur applications were also found to produce flour capable of producing better dough and a large increase in the critically important loaf volume.

More recent AHDB work carried out by ADAS in conjunction with industry partners including CF Fertilisers showed a lift in oilseed rape yields from 11 t/ha to 5 t/ha at one site and to a similar high level from about 1.5 t/ha at another.

The sulphur was also found to significantly improve oil content with a lift from 39% to 45% at one site and from 42% to 45% at the other.

Although yield responses to applying sulphur will vary depending on existing deficiency levels, soil type and crop, it is now widely accepted that where deficiency is evident, the effects of sulphur applications are considerable. In fact, it is now generally accepted that yield response is typically around 10% in winter cereals, up to 50% in spring barley and in oilseed rape, which requires a higher level of sulphur, increases in yield can be as much as 100% on deficient sites. (See Table 1.)

THE ELEMENT IS IMPORTANT

Sulphur helps develop and activate certain key enzymes and vitamins in the plant and is an essential structural component of two of the 21 amino acids that form protein. It is also used by plants to produce oils. The element is critical to chlorophyll production which, in turn, is essential for photosynthesis and plant growth.

The crop’s need for sulphur is closely associated with nitrogen requirement. It is a major component of protein and is also needed in the formation of chlorophyll. A plant takes up a certain amount of sulphur as it uses nitrogen, but unlike nitrogen, sulphur is not mobile in the plant, instead requiring a sustained source from the soil throughout the growing season.

Plants take sulphur from the soil in the form of sulphate (SO₄²⁻) so sulphur applied as fertiliser, in manures and in the soil to start with, has to be converted to this by soil microbes before it can be taken up by the plant.

IDENTIFYING A PROBLEM

Like many crop nutrition issues, often the only time you will know you have a problem is when it is too late to do much about it in that season.

Soil analysis isn’t always a good predictor of available sulphur because the element is highly mobile in the soil. However, a test called the malate:sulphur tissue analysis can be a reliable predictor of sulphur deficiency if you suspect problems.

In oilseed rape, deficiencies can often be seen as a whitening of new flowers – they simply don’t have the rich yellow colour expected of the crop – but soil

| TABLE 1 – TYPICAL YIELD RESPONSES TO SULPHUR APPLICATION |
|--------------------------|--------------------------|
| Winter cereals           | 10%                      |
| Spring barley            | 50%                      |
| Oilseed rape             | 100%                     |

Source: Various AHDB/ADAS and CF Fertilizers sponsored research.

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type can often be an indicator of likely problems, too.

Lighter soils in areas of high rainfall with low atmospheric depositions are especially susceptible to sulphur deficiency as sulphate, just like nitrate, is easily leached.

Deep, silty or clay soils are less vulnerable, but in most cases sulphur is still needed to protect against yield and quality loss. (See table 2.)

ADDRESSING THE ISSUE

In the early days, micronised sulphur applied through a sprayer was used but this rarely allowed enough sulphur to be applied and the necessary oxidation in the soil was an unpredictable process.

Ammonium sulphate (AS) can be used but it is not a balanced product and it is easy to apply too much sulphur, which acidifies the soil over time.

When used as a component in blended products AS can also produce uneven spreading due to variation in physical properties and particle size between nutrient components. Numerous reports exist of growers with crop striping and inconsistent growth as a result of using straight ammonium sulphate or urea-based nitrogen products blended with ammonium sulphate.

The most reliable and cost-effective options are purpose-made nitrogen and sulphur granular compounds which have a high density and the optimal range of particle sizes. DoubleTop (27N 30SO₃), and SingleTop (27N 12 SO₃) have proved to be the most popular of these for UK arable situations.

Such products not only ensure accurate applications of both nitrogen and sulphur in terms of kg/ha applied, they also facilitate even and consistent spreading to wider row widths.

In oilseed rape, the most practical time to apply sulphur is the first application in early spring (February/March). A single application of DoubleTop is advisable but in large crop canopies requiring less early nitrogen, it can be applied in two split dressings.

If applying as a single application on deficient sites, up to 112kg/ha SO₃ is recommended with this divided into two equal 56kg/ha applications for split dressings. If using manures, which supply an amount of sulphur to the crop, a typical application of 45kg/ha SO₃ has been shown to still produce a cost-effective yield response.

Winter wheat and barley respond to sulphur in the same way with adequate amounts of the element allowing plants to use nitrogen more efficiently. This is critical in malting barley with the higher yields produced diluting the amount of grain nitrogen.

Applications should be made in late February at growth stage 14-25 with extensive research and testing showing a single DoubleTop application of 52.5kg/ha SO₃ being the best option. SingleTop, with its lower level of sulphur concentration, can be used if a little and often strategy is preferred.

As is common in most areas of crop nutrition today, using quality products with known carbon footprints is more likely to produce a better and more cost-effective yield response and fulfil the requirements of increasingly discerning end markets looking for proof of environmentally sensitive production.

| TABLE 2 – SULPHUR DEFICIENCY RISK BY SOIL TYPE |
|-----------------|----------------|-----------------|
| Winter rainfall (Nov to Feb) | Low (<175mm) | Medium (175-375mm) | High (>375mm) |
| Sandy | High | High | High |
| Loam/course silt | Low | High | High |
| Clay, fine silt/peat | Low | Low | Intermediate |

Source: HGCA Information Sheet 28, Spring 2014

Use the questions below to check your understanding, or that of the people who work on farm with you. Readers can claim two BASIS points if the questions are answered correctly. ★★

BASIS REFERENCE NUMBER PN/54426/1617/h – Circle the correct answer (more than one may apply).

1. According to recent surveys, what is the percentage of winter wheat growers that still do not use any sulphur at all?
   A) 40%  B) 80%  C) 100%

2. What average yield benefit in responsive sites did ADAS find in early trials at its Rothamsted site for winter wheat treated with sulphur?
   A) 1%  B) 9%  C) 27%

3. What is a typical yield response to sulphur application on deficient sites for spring barley?
   A) 30%  B) 50%  C) 7.5%

4. What analytical test is preferred when determining likely sulphur deficiency?
   A) Soil analysis  B) NS plant tissue analysis  C) Malate:sulphate analysis

5. Which type of soils are most vulnerable to sulphur deficiencies?
   A) Light  B) Medium  C) Heavy

6. Which rate is recommended for a single application of DoubleTop on oilseed rape in February on very deficient sites?
   A) 56kg/ha SO₃  B) 112kg/ha SO₃  C) 224kg/ha SO₃

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