The forgotten nutrient

Essential in the process that gives green plants their colour, magnesium seldom gets as much attention as some other nutrients.

By Andrew Blake

If you're a car enthusiast, magnesium's likely to be associated with alloy wheels. But the element is a vital plant food, and for producers hoping to maximise profits, it merits more attention than automobile bling, according to industry commentators.

Magnesium's (Mg) role in plant metabolism has long been understood, notes independent consultant Chris Dawson. But in an International Fertiliser Society paper, written only five years ago, it was described as "the almost forgotten mineral nutrient", he notes. "Compared to the other major nutrients not a great deal of attention has been given to Mg in crop nutrition."

One specialist who believes magnesium deserves more consideration by growers is Jerry McHoul of K+S UK & Eire. "Around 170,000ha of oilseed rape need magnesium applications to achieve full economic yield," he says. "That's equivalent to about a quarter of the UK's 2011 crop.

"Magnesium's very important. It's a major (macro) nutrient, along with nitrogen, phosphorus, potassium and sulphur."

Although Ecopt's Ian Richards prefers to describe magnesium as a "secondary" nutrient, most crops remove 25-35kg of MgO/ha, he points out.

Magnesium is the central atom in the chlorophyll molecule which occurs in all green plants, he explains. "So photosynthesis depends on magnesium. However, only about 20% of the magnesium in a plant is in the chlorophyll.

> *"Magnesium's a major nutrient, along with nitrogen, phosphorus, potassium and sulphur."*

"Magnesium has an important role in the enzyme activators which are essential for protein formation and energy transfer."

Recent research has shown how Mg helps reduce damage to leaves caused by an accumulation of sugars in bright sunlight, notes Omex' Andy Eccles.

That's why the firm includes magnesium in its late-season foliar oilseed rape product, he explains. "Mg helps maximise the production of sugars and then their conversion into oil."

It also explains why so-called 'Mag on the Flag' treatments to cereals can impact on cereal thousand grain weights, says Jerry McHoul.

"Root crops are particularly responsive to magnesium since they're laying down large reserves of assimilates into storage organs," he adds.

"Magnesium for oilseed rape has been growing in significance, particularly since the latest edition of RB209 was published. OSR grown on an Mg index 1 soil now has an official recommendation of 50-100kg MgO/ha to recognise the crop's responsiveness. Previously a rotational application was advised only at index 0."

Too little magnesium can lead to poor yields, damaged leaves which can't photosynthesise efficiently, lower grain quality in cereals, and may increase susceptibility to certain diseases — alternaria in potatoes, for example, he adds.

Field observations suggest that varieties may differ in their need for magnesium, notes Agrii's Chris Bean. "There's breeder evidence of it in Lioness, for example, which needs more."

Predicting Mg deficiency

It's not hard to predict where and when plants may run short of magnesium, say experts.

Crops grown on light alkaline soils, subject to leaching, high in potash or with magnesium indices below 2 are likely to suffer deficiency, the condition being aggravated by dry springs and summers, warns Agrii's Peter Gould.

According to Ian Richards, deficiency is most likely in light sandy soils with low cation exchange capacity that retain little magnesium. "Symptoms can appear in crops on any soils in early spring, but

Leaf veins typically remain green, while the area in between, in magnesium-deficient oilseed rape, changes colour and leaf edges curl.

often they're transient and don't usually affect yield."

Deficiency is most likely on light sands and shallow chalk soils, agrees Andy Eccles, though many soils in the UK apparently have adequate levels of Mg.

According to the latest Professional Agricultural Analysis Group report, covering about 180,000 soil samples analysed between June 2010 and May 2011, only 12% had Mg indices of 0 or 1 where application of magnesium would be recommended for some crops, he notes.

"However, it's not just the level of magnesium in the soil that matters, as availability can be impaired by high levels of potassium, cold, wet conditions, very dry conditions and poor crop rooting."

Nevertheless, the PAAG tests did highlight a marked difference between magnesium in arable and grassland soils, says Jerry McHoul. "Some 26% of the arable soil tests showed results below the target index 2, whereas in grassland just 4% were below this threshold."

That finding reflects a detailed study in the late 1990s which found that most UK soils were inadequate or borderline in their ability to supply enough magnesium to counter crop off-take, he notes.

"Deficiency is most likely to arise during periods of stress and/or when uptake's very rapid, for example during flowering or very rapid vegetative growth under ideal growing conditions. Dry, cold conditions are often troublesome."

High levels of other positively charged nutrients in the soil, such as calcium, potassium, sodium, and ammonium, can reduce the availability of magnesium to plants, he adds.

"Advice on such soils is to apply magnesium in a water-soluble form, little and often, close to the point of need."

Signs of deficiency

Spotting signs of Mg shortage in crops is relatively easy, compared to detecting deficiencies of other elements, says Chris Bean.

"The symptoms are quite distinct — interveinal chlorosis and yellowing on leaf margins."

Symptoms of magnesium deficiency in crops tend to occur when the concentration in the green material dry matter falls below 0.2% Mg, explains Ian Richards.

"Early symptoms include the loss of healthy green colour between the veins. This may be followed by yellowing (chlorosis), which starts at the leaf tips and margins and progresses inward until the entire leaf's chlorotic. Curling of the leaf margins follows, and then death of these areas and premature defoliation.

"These symptoms can be confused with nitrogen or manganese deficiency. A mottling, dark green/light green appearance is more typical of magnesium deficiency. The leaves of some plants, for example strawberries, can turn orange or reddish. But in cereals, deficiency causes the distinctive green/pale green mottling."

Magnesium's one of the easiest deficiency symptoms to spot in broadleaved crops, says Jerry McHoul.

"The leaf veins typically remain green while the area in between takes on a marbled yellowing appearance from the lack of chlorophyll and because of photo-oxidative damage. These symptoms are reduced if sunlight's excluded.

"The older leaves are affected first as the plant moves ▸

Sugar beet and potatoes are more likely than other arable crops to show deficiency, says Ian Richards.

▸ magnesium to the area of greatest need — the growing point.

"In cereals you get a spotting/marbling effect running broadly in lines or streaks along the leaf blades and again, this is seen first mostly on the older leaves.

"In both crop types, prolonged and/or severe deficiency results in death of tissues starting at the leaf margins with eventual loss of leaves."

Magnesium shortage in potatoes can be particularly obvious, says Andy Eccles. "It occurs only on older leaves, which become pale, while the veins and leaf margins remain green. Brown spots then often develop.

"Sugar beet initially displays interveinal yellowing, starting on outsides of older leaves and extending towards the midrib, with yellow blotches developing. Given time the leaf margins become brown.

"Cereal symptoms are sometimes seen in dry summers."

Detecting deficiency

Soil analysis and tissue testing can both be employed to indicate magnesium deficiency. But bear in mind the key risk factors which make it more likely to occur, for example light soils and susceptible crops, urges Ian Richards.

"In the UK, sugar beet and potatoes are more likely than other arable crops to show deficiency, though it's quite difficult to find trials showing a yield response in potatoes.

"If there's a risk, make sure that your soil analysis is recent, and check to see if there are any trends towards deficiency in previous crops."

Soil testing may indicate adequate levels, but availability can be impaired by extremes of moisture and restricted rooting, warns Andy Eccles. "So tissue or sap testing's generally regarded as the most accurate confirmation of deficiency. Sap testing can be more effective at identifying latent deficiency, before symptoms become apparent."

Magnesium's always reported in a standard soil analysis package and is an accurate way of discovering the level of the element in soil, notes Jerry McHoul.

"Unfortunately, the pH, P and K findings are usually addressed, but the Mg status, perhaps from a lack of understanding, is often ignored.

"Tissue tests are also useful, but take care to sample similar leaves at a similar time from a representative number of plants when comparing season to season results.

"A general threshold value for most crops is around 0.15-0.2% Mg in tissues. Lower values can indicate deficiency. Note that magnesium in tissue tests is reported as Mg (not MgO) and is on a percentage of dry matter basis."

Likely responses to correcting deficiency

Agrii experience shows that benefits from applying Mg can occur irrespective of potential soil supply.

"Even on non-deficient soils we've had 0.3t/ha responses to foliar magnesium in oilseed rape and 0.4t/ha in wheat," says Peter Gould.

Severe deficiency can lead to crop stunting and even crop failure, says Andy Eccles. "This is fairly rare, however, and yield responses to foliar applications of magnesium depend on individual situations — but they can be large if deficiency's identified early and fully corrected.

"There's a lack of independent work on responses to soil-applied magnesium, but quite a lot of manufacturers' data."

Deficiency symptoms which can lead to yield loss in sugar beet usually appear from July, notes Ian Richards. "Trials in the late 1990s suggested plants need leaf tissue levels from August to October of at least 0.25% Mg in dry matter.

"On soils with an Mg index of 0, the average response to an application of 100kg/ha MgO as kieserite was reported as 0.33t/ha of sugar, but in some crops the figure was as high as 2t/ha."

More recently K+S UK & Eire have commissioned a large number of field trials in the UK in cereals, potatoes, sugar beet and oilseed rape, says Jerry McHoul. "They were over a range of typical soil types for those crops with Mg indices of between 0 and 1."

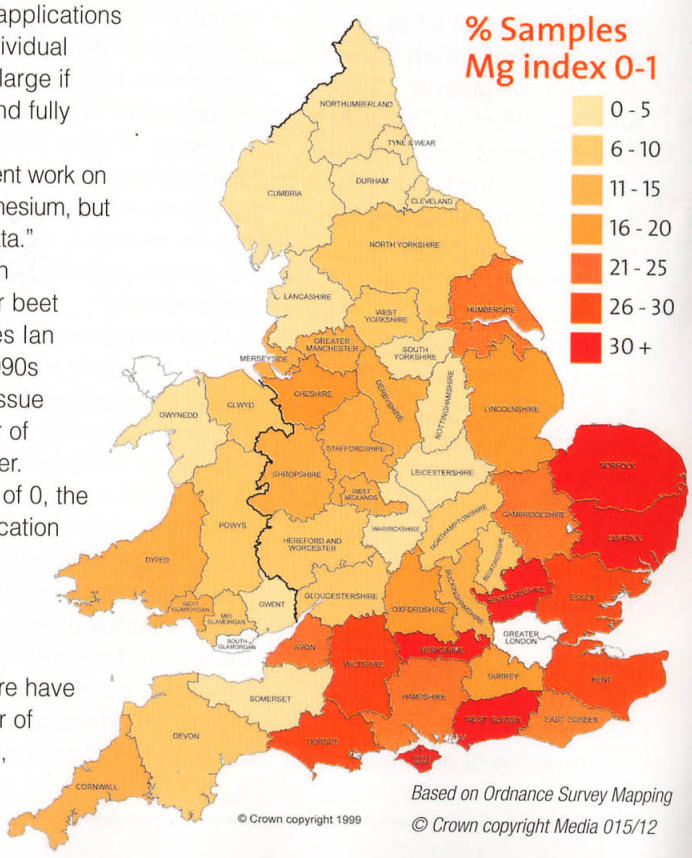
"Responses from both soil-applied and foliar magnesium were investigated, and all work was carried out by Armstrong-Fisher trials services over a five-year period with the following results.

"Applying kieserite at 100kg MgO/ha resulted in a mean yield increase of 4.1t/ha of beet and an increase in sugar content in every trial over four years of 0.1-5%.

"In three of the four years, amino N was also reduced in crops treated with kieserite. It's worth noting that the yield response from calcined magnesite at an identical rate was less than 1t/ha."

In cereals, deficiency causes a distinctive green/pale green mottling.

Most UK soils are unable to supply enough magnesium to counter crop off-take.



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Foliar magnesium gave an average increase of 2.8t/ha, although there were small quantities of boron and manganese within the Epsom salts-based product, he notes.

The same rate of kieserite to potatoes saw a mean yield lift of 3.3t/ha, while a foliar program of five applications of EPSO Microtop produced an extra 3.2t/ha. "In both cases the magnesium content of leaves was increased by 25-30%.

"In oilseed rape and cereals, we've investigated responses to a maintenance application of magnesium (typically 10-20 kg MgO/ha) and were shocked by the responses in most trials.

"Oilseed rape responses on some sites were negligible, but on others consistently 0.2-0.25t/ha. The mean from all trials was 0.13t/ha. In cereals it was 0.2t/ha."

Sources and application

Practical sources of magnesium available to growers fall into two groups.

Kieserite and potash plus kieserite products, for example Korn Kali, and manures can be used as soil dressings in the autumn or spring. But they're best applied in Feb at the start of spring growth to minimise leaching and maximise uptake, advises Chris Bean.

Foliar options include magnesium sulphate (known as Bittersalz or Epsom Salts), magnesium nitrate (as in Agrii products Optemag or Magister). "They're applied as needed little and often, frequently with fungicides."

Over the longer term magnesian limestone, applied as a liming agent, will raise magnesium soil levels, notes Ian Richards.

"Other fertilisers, such as calcined magnesite and magnesium hydroxide are sometimes used."

Peter Gould has seen foliar magnesium bring a 0.3t/ha response to oilseed rape.

Omex uses colloidal magnesium hydroxide which is effectively converted calcined magnesite, says Andy Eccles. "It's formulated into suspension fertilisers, along with NPK, sodium, sulphur, and micronutrients as required. ■

- Look out for the nutrient deficiency poster in this month's issue, that gives you a quick-reference guide to the key symptoms to watch for.

Magnesium or magnesium oxide?

The usual convention is to express nutrient concentrations in plant tissue and in soils in he elemental form, ie Mg, says Ian Richards. To convert from MgO to elemental Mg, multiply by 0.6. "Although MgO is used in fertiliser declarations, apart from calcined magnesite, fertilisers do not actually contain MgO and plants take up magnesium as Mg ions," he adds.