A NUE approach to molybdenum

Applying molybdenum as a spring fertiliser coating has been proven to fire up nitrogen conversion and play a key role in improving nitrogen use efficiency.

Intro

The term nitrogen use efficiency or NUE has become the holy grail in arable circles recently with growers focussing on small gains to improve the plant's access to any fertiliser that is applied, and the interaction molybdenum has with nitrogen (N) shouldn't be underestimated.

The outcome of two recent trials has shown there are significant gains in both crop yield and nitrogen use efficiency by applying molybdenum as a spring fertiliser coating to a nitrogen application.

The trials took place on crops of spring barley and winter wheat during 2021 and highlighted the relevance of knowing the properties of individual micronutrients to improve the use of nitrogen. Peter Scott, technical director at Origin Fertilisers, says that although molybdenum is used in the plant to break down nitrogen, growers shouldn't forget it has an essential role in soil biology, too.

"Micronutrients have different properties and react with nitrogen in a variety of ways. We know that molybdenum is key to nitrogen uptake, but we wanted to find out by applying it to the fertiliser granule would it have a greater or lesser effect on the plant's ability to use nitrogen, and would more nitrogen be available in the soil."

NUE improvements

The spring barley variety under the microscope was Laureate on the trial which took place in Angus, Scotland. The Origin molybdenum coating on both the seedbed and top-dressing fertilisers was compared to a seedbed NPKS and nitrogen/sulphur top dressing.

"Key findings highlighted an increased yield of 3.5% over the standard application and an increase in nitrogen use efficiency of 8.9%. Of equal interest to the grower would have been a return on investment of 6:1, meaning the coated fertiliser application had a positive impact on the bottom line," explains Mr Scott.

"It was a similar story in the winter wheat trial that was carried out in Yorkshire. An increase of 5.4% in NUE was achieved, along with a 1.1% lift in yield. The treatment offered a 2:1 return on investment. The gains in yield and NUE will be welcomed by farmers keen to understand how micronutrients play an integral role to soil and plant biology."

NUE is well recognised in academic circles and has gained profile through the work and publications of EU Nitrogen Expert Panel, which brought together policymakers, industry and scientists to rigorously test its application as a policy driver and for its practicality on farm, comments Jane Salter, head of environmental policy at AIC. She went on to say that improving NUE has significant importance to agriculture now and in the future.

"There are no downsides to NUE – the farmer gets more crop per kg of N, the environment benefits from less available N potentially being lost as ammonia, nitrous oxide and nitrate, and there's a political win all round for achieving it.

"I can't overemphasise the importance of nutrient management as part of the national food strategy and new environmental targets currently being consulted on. The next 10 years are

crucial; our cropping systems must be more resilient to meet net zero, water, soil and air quality commitments made in the 25-year Environment Plan. We cannot lobby the environmental pressures away; farming and the environment are inseparable and finding solutions that work for both must be the way ahead."

Application details

The trials began with a broad-spectrum soil analysis of the field, which highlighted low molybdenum levels and a pH of 6.8 across the clay loam soil. Applying molybdenum in the most efficient way to act as a catalyst for the nitrogen was a key finding from the trial, as Mr Scott explains.

"The availability of most micronutrients increases as soils become more acidic, so a lower pH, whereas molybdenum is the opposite and will increase when soil pH is higher. Growers with a soil deficient in molybdenum should be evaluating the best way to get molybdenum to where it is required.

"Micronutrients are usually applied as foliar. However, these results highlight molybdenum applied as a coating on nitrogen fertiliser has the greatest impact as it feeds both the crop and the soil bacteria that require molybdenum as a catalyst to function."

This insight was gleaned from a tailored application of Origin Fertilisers' NUE-Trition range, that uses micronutrient coatings on fertiliser such as molybdenum. Even if the soil is showing as not deficient, farmers should be applying this key nutrient to improve the sustainability of nitrogen by helping more of it be taken up by the crop rather than it be lost to the environment through nitrate leaching, denitrification, or ammonia volatilisation.

"The Origin molybdenum coating is applied to the granules in the form of a dry powder that has an electrostatic charge and doesn't require a liquid to attach it to the fertiliser. The dry powder acts like a magnet and disperses evenly across the granule," says Mr Scott.

"Recognising a soil is deficient in certain nutrients allows a detailed and prescriptive fertiliser application tailored to correct these issues, and a micronutrient coating on a fertiliser granule allows it to start working as soon as the nitrogen begins to dissolve."

Ms Salter agrees and says that understanding the key drivers for improving NUE starts with soil health and a good nutrient balance.

"We need farmers, with the support of their FACTS qualified advisers, to be able to understand NUE and the factors influencing it, measure it, and set crop level targets for percent improvements over time. It is also looking probable that future farm payments will incentivise our joint commitment to driving NUE, which indicates government and wider stakeholder support now," comments Ms Salter.

Essential for soil bacteria and plant enzymes

To achieve this, growers need the tools to understand how improvements can be made. Molybdenum is a naturally occurring metal and its presence in the soil aids the conversion of nitrogen from ammonium to nitrates. But as Mr Scott explains, we should think of molybdenum's interaction with nitrogen in two parts.

"Molybdenum is the catalyst required for the conversion of nitrogen and is essential for soil biology. It sparks a reaction in soil bacteria enzymes that stimulate the nitrification process. The second part of molybdenum's role is the conversion in the plant of raw nitrogen into protein.

“In the soil, nitrogen starts off as ammonium, and during nitrification it loses hydrogen and gains oxygen, changing it from ammonium into nitrite and then nitrate. By firing up nitrification with molybdenum as the main catalyst, we are increasing the ease with which plant roots can access and consume nitrogen from the soil.”

Although not applicable to cereal crops, molybdenum’s presence in helping legumes, such as peas and beans, fix nitrogen into the soil can give a wider appreciation of its importance when looking at nitrogen use efficiency enhancers.

“Legumes are well known for their ability to fix atmospheric nitrogen using nodules that form on the roots of the plant, and the metal catalyst needed for this is molybdenum. It acts as a metallo-catalyst to fix nitrogen from the atmosphere and lock it into the nodules.”

Plant molybdenum requirements

It is a key component in the soil, but plants will only be able to take up so much nitrogen before they reach capacity. Plants need to be able to convert this nitrogen into protein through an enzyme called nitrate reductase, and an essential catalyst for this is molybdenum.

“A shortage of nitrate reductase in the plant will cause it to slow down its nitrogen uptake. In a similar way to when we are full, we need time to convert the food into energy, the plant requires molybdenum to convert nitrogen into protein, and therefore allow room for more nitrogen to be taken up. This process is called nitrogen assimilation.

“By choosing to apply molybdenum as a foliar application, it could mean that levels in the soil are low, and it means the plant has to work harder to access nitrogen, therefore reducing the efficiency with which nitrogen is converted.”

Due to its close relationship with nitrogen, a soil deficient in molybdenum can lead to the plant showing the same symptoms as one with a nitrogen deficiency. Molybdenum is mobile within the plant, which means older leaves are affected first with a pale, yellowing of the smaller leaves. Growers on sandy soils with low cation exchange capacity (CEC), are likely to have low molybdenum holding capacity, too. Conversely, soils with good organic matter content will hold onto molybdenum well, Mr Scott adds.