

Playing NUE detective



Sustainable Solutions

Making sure crops get ‘just enough’ of the right nutrients at the right time so that they have every chance of living up to their potential requires some detective work. *CPM* takes a forensic look at some of the tools available to help plants make best use of available nutrients, maximising NUE.

By Lucy de la Pasture

Until relatively recently, crop nutrition has taken a simple approach to a complex issue. The nutrition bible has been RB209, which essentially looks at the amount of nutrient the crop will require while taking into account the soil indices for phosphate, potash and magnesium.

But following some of the real clues that indicate just how well crops are utilising nutrients can help identify where things aren't optimal and where crops aren't getting all the nutrients they require, even if soil analysis indicates they are in plentiful supply.

Jim Carswell, Agrii R&D manager, has advocated a tailored approach to crop nutrition for a long time and recommends growers look back at last year's crop in

order to consider the requirements for the one currently in the ground.

“I encourage people to get a post-harvest grain analysis done as this will reveal any gaps in their nutrition strategy. It's also the key to working out nitrogen use efficiency (NUE), which requires forethought and planning to do properly,” he says.

NUE has become a prominent metric, partly because of the increasing price of synthetic fertilisers but also because capturing and retaining nutrients in the crop provides a public good by safeguarding the environment.

So what exactly does NUE mean? Jim explains that it's a measure of the efficiency with which N — the most critical crop input both economically and environmentally — is used.

“NUE describes the efficiency with which N is taken-up, metabolised and partitioned and it fundamentally depends on the balance of all the other essential nutrients as well as soil and plant health.

$$N \text{ use efficiency (NUE)} = \frac{N \text{ removed in harvested crop (kgN)}}{N \text{ supply from all sources (kgN)}} * 100$$

“Although NUE may be the key measure, improvement efforts really need to be focused on nutrient use efficiency, rather than nitrogen alone. That's the key to reducing nutrient wastage, getting better crop performance, having lower environmental impact and increasing profitability.”

Agrii has looked at NUE across its northern iFarms and has found that it's something that varies hugely between

“Getting the rate of nitrogen right is vital for profitability and for environmental considerations.”

locations, crops and seasons.

“In winter wheat, we saw NUE vary from 71.6% to 101.5% (indicating some available N wasn't accounted for) last season, whereas in 2021, the range was



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Technical seed treatments in spring barley



Figures show return on investment.

Source: Agrii iFarms: six trials at four sites, 2016-18

58.3 to 67.1%. In OSR, the NUEs were lower with 2022 values ranging from 46.5% to 56.6% compared with 47% to 57.1% in 2021.

“Some of the factors influencing NUE can be managed, such as soil structure, health and pH; use of organic manures; crop type, variety and rotation; nitrogen type, timing and application; other macro and micronutrients; agronomy; as well as cultivations and drainage. Other factors are out of your control, including soil texture, climate and topography,” explains Jim.

Enhancing in-season

There are a number of things that can be done to enhance NUE in-season and Agrii has looked at the value of these at Bishop Burton in East Yorkshire and a number of other iFarms. Many of these utilise the other tools Jim considers vital for managing nutrient use efficiency. These include broad spectrum soil analysis, accurate N-min testing and effective tissue analysis — when taken together with grain analysis this completes the circle of monitoring for the life of the crop.

Jim’s a great believer in the adage that the most important day in the life of a crop is the day it’s planted. It also provides the first in-season opportunity to boost NUE, he says.

“In our trials, starter fertilisers have really helped to maximise early growth and development,

setting up the yield potential of the crop and equipping it to better deal with any subsequent challenging conditions.”

Using the clues gleaned from previous grain analysis, soil and historical tissue analyses, planting is the time to begin to address any nutritional gaps that are likely to arise due to nutrient interactions or inadequate soil supply, highlights Jim.

“Ideally, drill or place fertiliser to optimise early root uptake, making sure there’s available phosphate to support root growth, conserving the plant’s energy and reducing stress. Manganese and zinc are also very valuable as Mn boosts chlorophyll production and N utilisation, while Zn stimulates auxin production and hence growth.”

It’s not just when nutrients aren’t present in sufficient quantities that a benefit can be seen, adds Jim. “Soil pH should be factored in too, with sub-optimal pH having a major effect on nutrient availability, particularly phosphate,” he says.

“In many cases, routine additional early nutrition can be really valuable. Plugging a potential hunger gap also helps the crop stay ahead of blackgrass during autumn,” he believes.

“By using a basal fertiliser, it’s possible to take a more targeted, precision approach right from the word go,” he adds. “For some, it may be ▶

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► more appropriate to supply starter nutrition in other ways and seed treatments is one way of doing this. Phosphite is a very effective biostimulant seed dressing that has many years of usage behind it.”

Agrii trials have shown benefits from both starter fertilisers and technical seed treatments across different crop types, with consistent yield responses in spring barley, pulses, and winter oilseed rape. Wheat trials showed particular positive responses to manganese-coated TSP on soils with a high P index but low pH.

Some of the most important sleuthing helps determine just how much nutrient has to be applied to the crop — balancing what the crop will require to fulfil its yield potential, while taking

account of both the soil mineral nitrogen (SMN) supply and the additional nitrogen that will become available in the soil as the season progresses, explains Jim.

“Getting the rate of nitrogen right is vital for profitability and for environmental considerations. We found in our iFarm trials last season at Bishop Burton that reducing the rate of N by 40kg/ha had a negligible adverse effect on yield or specific weight in winter wheat, with just a small reduction in grain protein.”

The trials looked at 13 varieties of winter wheat and eight varieties of winter barley on the site's high pH, sandy silt loam soils with high indices for both P and K.

For winter barley it was a

Gathering the evidence

Making good cropping decisions is all about evaluating the evidence to support them and for Peter Cartwright, who manages the 1220ha Revesby Estate in Lincolnshire, that means having trials on the farm.

Peter has been doing large block evaluations since 2018, says Tom Land, Agrii's regional fertiliser manager. “With our team, he's been generating a huge amount of data looking at 40m wide plots and evaluating different varieties, N rates and timings, and NUE on the mainly clay loam ground. In 2022, the trials also investigated varietal performance, with and without fungicide inputs and PGRs.”

On 15 October 2021, 19 varieties were direct drilled at 350 seeds/m². The SMN level was assessed as 60kgN/ha and in the spring, nitrogen was applied at different rates — 170kg/ha, 220kg/ha, 270kg/ha — in three splits (9 March, 14 April and 4 May). An untreated control plot received 220kgN/ha.

Peter applies strict criteria when it comes to interpreting the results of his large block trials. In the untreated plots, varieties must achieve 8t/ha as a minimum to be

credible. The second metric he applies is for the treated crops, which he likes to see perform with yields no less than 10t/ha.

With very little information available regarding the NUE of different varieties, Peter's results make for interesting reading and are showing some apparent differences in the performance of varieties using his metrics — especially when no fungicides or PGRs were applied.

The data from the Revesby trials does pose the question, what do you want from a variety? For Peter it's not outright yield that makes a variety a good performer, says Tom.

“For him, the resilience of a variety and the margin take priority and he's able to assess varieties best suited to the farm by analysing the data from the large block trials.

“In 2022, reducing nitrogen by 50kg/ha across all the varieties (220kgs v 170kgs) reduced margins by £205/ha, so it clearly didn't pay. As for consistency over years, Graham, KWS Extase or Fitzroy have been leading in the work, but for 'safety and resilience' LG Tapestry, KWS Cranium and RGT Bairstow are amongst those standing out on this site.”

very different story, he explains. “Reduced N rates gave a marked reduction in ear numbers with a direct consequence for yields. Although this was one site in one season, I’d expect this effect to be representative of the outcome from reducing N on different sites and in different seasons. It’s the number of tillers — and therefore ears/m² — which are key yield determining factors in barley.”

There’s been a definite trend over recent years for the spring period to be unusually dry. Many growers are adapting to this new norm by shifting their fertiliser applications earlier.

“It’s a good idea to use a nitrification and/or a urease inhibitor with liquid fertiliser or solid urea when applying the bulk of N early in the spring and it provides another opportunity to improve NUE. In trials, we’ve found it’s possible to move to a two-spray approach, rather than the more traditional three-way split, by adding Liqui-Safe (maleic acid+ itaconic acid) to the tank.”

The trials at West Lutton in Yorkshire took place on a silty clay loam soil in six replicated strips of SY Insitor. A total of 200kgN/ha plus 59kg/ha SO₃ was applied as liquid UAN in two splits, with and without Liqui-Safe. Adding the urease and nitrification inhibitor improved average yield by almost 1 t/ha at same level of total N supply.

Further trials at Stow Longa investigated the importance of balancing macronutrient supply in 2020/21. The Cambridgeshire soil is a high pH, high calcium clay ground, with indices of 2+ for P, K and Mg. A mixture of second, third, fourth, fifth and sixth crops of Skyfall were late-October sown, with identical crop protection and micronutrition.

“The aim was to look at N rates and timing as well as key supporting nutrients,” explains Jim. “High yields of the Group 1 specification milling wheat were

produced from 100kgN/ha less than is commonly applied. The best results came from a back-loaded N timing where the supporting nutrition was balanced to overcome classic mineral lock-up on this soil.

Having already touched on the benefit of fresh phosphate to crops, Jim moves on to work done at Bishop Burton in 2021/22. This explored the use of a phosphate availability enhancer to overcome any soil induced limitations.

“In this trial we looked at 13 winter wheat and 17 WOSR varieties and applied the enhancer, Agrii Start Release, in autumn or spring and at both timings. We found there were considerable all-round improvements in crop growth and clear yield benefits without any loss of crop quality. These benefits also translated into marked improvements in NUE and margins.”

Seasonal influences

It was perhaps the timings of treatment that yielded the most interesting information in the trial. “There was no overall autumn response in the wheat last season, probably because sufficient rainfall is required after application to take the product down to the rooting zone. In a similar 2020/21 trial, though, we got a considerable benefit at this timing when conditions were wetter,” explains Jim.

The P-enhancer contains tricarboxylic acid which works by preventing Ca from binding to P in the soil, which would lock it up. Jim believes it makes sense to use such a product if no fresh P is being applied and says in the autumn it will help make P available to enhance rooting and in the spring it can ‘wake the crop up’ to help improve early N utilisation.

Although they may not be required in the same quantity as macronutrients, micronutrients are also essential to crops — often acting as catalysts to many important biochemical

Response to N timing and macronutrients, winter wheat

Treatment*	N (kg/ha)	Yield (t/ha)	Protein (%)	NUE (%)	Gross Margins (£/ha)
1: Standard N	214	8.47	12.0	67	£803
2: Reduced N	164	8.29	12.4	83	£840
3: Reduced N (back-loaded)	164	8.90	13.7	98	£1030
Standard N + K/S	214	8.65	13.7	78	£901
Low N + Spring S/K/Mg/Ca	164	8.90	13.7	98	£1030

Trials took place in Skyfall winter wheat

Nitrogen: treatments were balanced with a spring dressing of 48 S03:14 K:6 Mg:17 Ca. Reduced N merely eliminated final nitrogen split. Back-loaded treatment received reduced N early to provide in final split.

Macronutrients: both treatments had a similar balance of mid and late season N. Standard N received 60kg/ha early with balanced S and K. Low N received a dressing of 48 S03:14 K:6 Mg:17 Ca instead of early N with K and S.

Source: Agrii, Stow Longa 2021

processes within plants. For this reason, their adequate supply is intrinsically linked to NUE and improving this aspect of overall nutrition was something the Agrii team also investigated at its Bishop Burton site last season.

“We looked at 13 winter wheat varieties and supplying additional Ca. We also investigated 23 OSR varieties/seed treatments with regards to Cu supply. In both cases we found solid improvements in crop performance from providing extra micronutrients identified as likely to be lacking in previous grain and tissue testing,” comments Jim.

It highlights the importance of detective work — tracking the

nutrient status of the crop through to harvest to identify possible hunger gaps which may not have immediately come to mind and helping the crop’s NUE and, ultimately, yield.

“If you read the textbooks, OSR isn’t generally responsive to Cu, but OSR seed analysis indicated sub-optimal copper levels and we’ve seen a response from supplying it. Making use of all the analysis tools means you can follow the clues and tailor a nutritional approach to each crop. There’s also a role for biostimulants to boost crop physiology, which is another thing that can help boost NUE in-season,” he concludes. ■

Sustainable Solutions

With input prices still high but grain and oilseed prices struggling to maintain the level reached in 2022, there’s little doubt that the stakes are rising in 2023. That means making decisions on the farm which maximise profitability have never been more important.

In this new series, *CPM* has teamed up with Agrii’s Green Horizons initiative to explore ways in which farm-focused research is helping to raise both economic and environmental sustainability.

Increasing nitrogen use efficiency is just one part of this initiative’s practical programme of action, which includes charting paths to net zero, maximising soil health and evaluating crop protection alternatives as well as all-round farm efficiency improvement.

Up-to-date information on all these areas is available from www.agrii.co.uk/greenhorizons

