> *If we can start growing decent crops of wheat with 100kgN/ha, it's a game changer.*

AHDB

from theory to field

Developing practical N strategies

During what's undoubtedly been a difficult season for in-field experiments, *CPM* finds out what the nitrogen trials on AHDB's Strategic Farms are indicating.

By Mike Abram

What is it about farmers called David? All four of the current AHDB Strategic Cereal Farm hosts have that first name, but the similarities don't end there – they also share an instinctive interest in undertaking practical on-farm research, which is one of the key missions of the initiative.

The network was established in 2017 with the first AHDB Strategic Cereal Farm for the East hosted by Brian and Patrick Barker in Suffolk. The aim was to move away from small plot trials in favour of implementing scientifically robust work on a commercial scale, explains Henny Lowth, senior knowledge transfer manager for AHDB, who oversees the Strategic Cereal Farm programme.

"It helps to provide insight from the farmers into what does and doesn't work practically within their farming systems. In small plot trials, that real-world view can be lost," she says.

The network also provides an opportunity for farmers, not just the hosts but visitors to Strategic Farm meetings, to interact with researchers. "It's become a hub for researchers to hear from farmers about their research in a helpful environment."

Focus areas

Each farm has selected – with the help of its steering group – 3-4 different areas to focus its trials and research efforts. Unsurprisingly, given recent volatility in pricing plus the ongoing social and environmental pressures on its use, nitrogen fertiliser and its efficiency has become a common interest on three of the four farms.

Nitrogen rates on wheat have typically followed the national trend during the past 10 years for David Jones, host of the Strategic Cereal Farm East in Morley, Norfolk, with a reduction from around 220kgN/ha to 200kgN/ha and below since 2021.

"David [Jones] wanted to try and improve his nitrogen use efficiency and reduce his reliance on mineral-based fertiliser," says David Clarke, soils and farming system specialist for research partner NIAB.

"One approach is to reduce the amount of soil-applied nitrogen and use a polymer urea-based foliar product instead."

The claim for polymer urea products is, applied to the leaf, they have high bio-availability of the nutrients resulting in much higher nitrogen use efficiency. "If the efficiency of these products is higher, you shouldn't see a yield difference despite a lower total amount of nitrogen applied," explains David Clarke.

The Strategic Cereal Farm programme helps to provide insight from farmers into what does and doesn't work practically within their farming systems, says AHDB's Henny Lowth.

2024 research areas on Strategic Cereal Farms

North – David Blacker
- Nitrogen use efficiency – soil v foliar applied
- Living mulch & compost impact on soil biology
- Old v new drainage effect on soils and crop performance

East – David Jones
- Cultural grassweed control performance
- BYDV – decision support tools and varietal resistance
- Nitrogen use efficiency – soil v foliar applied

Scotland – David Aglen
- Cover crops – drilling date / termination method impact on following crop performance
- Management practices influence on biodiversity
- Nitrogen use efficiency – soil v foliar applied in direct drill system
- Interaction between tailored nutrition and standard agronomy on crop health

South – David Miller
- Cover crop choice influence on nitrate leaching and following crop performance
- Regenerative system field management impact on soil health / crop performance
- Companion cropping in winter wheat
- Impact of farm management on grain nutrients

Typical practice is to use foliar nitrogen to replace soil-applied products later in the season and in the case of Morley Farms', that'd be the last of three splits when 30-50kgN/ha is typically applied in early May.

Historic soil moisture data recorded at Morley 2014-2023 indicates that soil moisture declines during April into early May. That might make uptake of soil-applied nitrogen less efficient, whereas applying it to the leaf should bypass that issue, suggests David Clarke. "The rationale is replacing soil-applied nitrogen with foliar might overcome some of those limitations," he adds.

As part of his PhD studies, David Clarke has been validating the Sirius nitrogen model developed by Rothamsted Research, which could potentially help to understand nitrogen use efficiency within crops.

Using measured soil data from a long-term trial at Morley where different rates of nitrogen are applied from 0 to 250kgN/ha to calibrate, David Clarke has been able to show the model can accurately predict crop growth, grain yield in response to nitrogen and grain nitrogen uptake to within 22kgN/ha.

With increased confidence in the model's accuracy, David Clarke used it to estimate the nitrogen use efficiency of each application using 29 years of recorded weather data, plus average farm benchmarks for drilling date, soil properties and residual soil nitrogen from previous crops.

Perhaps unsurprisingly, the model suggests nitrogen use efficiency for the first two splits is high at 98% and 83% respectively. "But our simulated nitrogen use efficiency for the third split is down to 47%, suggesting it is something to change."

The yield response to the last timing was, on average, only 0.1t/ha, he notes, although it varies by season. "From previous AHDB research in the LearN project we know the last 30-35kgN/ha typically only increases yield by a very small amount."

This information led to one of the Strategic Farm's trials last season, where replicated tramlines were treated at the last split with either with the farm's standard 38kgN/ha soil-applied nitrogen, or the equivalent amount of the foliar nitrogen product. Other tramlines were untreated at the last timing to provide a control.

Both soil electrical conductivity and satellite maps were used to ensure the site was even in previous yield performance, soil type and in-season nitrogen uptake before the work began.

Yield results

Yields were then recorded via both mapping and by accurately weighing each cut treatment swath individually. "Yield mapping slightly underestimated yields, but there was a consistent relationship between it and the weighed yields," says David Clarke.

Within the trial strips, the soil-applied nitrogen generated a yield response of around 0.3t/ha and 0.5% boost in grain protein over the strips that didn't have any nitrogen at the later timing, he reports, with yields of around 10t/ha.

That almost matched the recommendation from Yara's handheld N-tester of applying 40kgN/ha for the last split for a 10t/ha target yield, he highlights. "But we didn't see any response from the foliar urea treatment, where yields and grain protein were almost identical to the untreated."

On David Blacker's farm, difficult weather played a role in his wheat crop failing to respond to an initial 70kgN/ha of soil-applied nitrogen at the first split.

That could be down to a couple of factors, he suggests. "It was a good year for soil-applied nitrogen – soil moisture was above average for most of the year so we didn't see the deficits you might expect.

"There was also some septoria in the crop which could have affected the foliar products – obviously when you're looking for leaf uptake you want as much green leaf area as possible."

A similar trial will be repeated during the coming seasons to build a larger dataset on how much response farmers can expect from these products, he adds. "It's also a demonstration that a well set-up tramline trial like this, using either yield monitors or weighbridges, can be useful in determining if changing strategies is worthwhile on farm.

"Concentrate on finding a good even site when setting the trial up to give you the best chance of identifying differences," advises David Clarke.

However, on the other Strategic Cereal Farms where foliar nitrogen has been trialled against soil-applied nitrogen, the results have been mixed. In the North on David Blacker's farm, difficult winter and spring weather played a role in his wheat crop failing to show any response to an initial 70kgN/ha of soil-applied nitrogen at the first split.

"A soil mineral nitrogen test suggested most of this was lost to the atmosphere by denitrification or in drainage water," explains Henny.

But with roots compromised after sitting wet, it gave an opportunity to assess the merits of a slow-release foliar product. As such, two treatments of a foliar application were tested against the farm standard of completely soil-applied 160kgN/ha.

As part of his PhD studies, David Clarke has been validating the Sirius nitrogen model developed by Rothamsted Research, which could potentially help to understand nitrogen use efficiency within crops.

The first had a foliar treatment of 10kgN/ha followed by a soil-applied 50kgN/ha as the third split, while the other treatment had the soil-applied dose first followed by the foliar application.

"It means the total dose of nitrogen for the one with foliar applications was 130kgN/ha, but that's considered equivalent to 160kgN/ha with extra use efficiency," adds Henny. "The idea was, with poor root growth could we give a boost by applying nitrogen through the leaf."

Even so, the yield results suggest that didn't happen with both foliar treatments yielding 0.8-0.96t/ha less than the soil applied nitrogen, she comments. "Economically, for it to break even as the foliar product was cheaper, the yield penalty had to be less than 0.2t/ha to make it viable."

Mixed outcomes

That level of loss has put David Blacker off from continuing to explore foliar nitrogen products, says Henny. "It doesn't necessarily mean it's not going to work, but David [Blacker] doesn't see it as a financially viable option."

In Scotland, David Aglen is much more positive about the use of foliar nitrogen following three years' trials and commercial use. The latest trial compared ammonium nitrate, liquid UAN, and a third treatment starting with liquid urea with remaining applications with a foliar urea nitrogen product, he explains.

Yields were similar despite the foliar treatment receiving 30kgN/ha less than the 200kgN/ha total in the ammonium nitrate or liquid UAN treatments. "They were all over 10t/ha and within a 0.16t/ha of each other, so it wasn't significant in my eyes."

He wonders whether foliar nitrogen is working more effectively for him in the North because of more favourable application conditions. In Australia, research suggests a combination of humidity and temperature can be used to help judge when to maximise nutrient absorption into the plant and avoid rapid evaporation rates.

"Our application windows when you look at that are massive, and my suspicion is further south where the air is drier, it might have more of an impact. If you apply on a dry day with a drying wind, the water part of the solution evaporates before the urea molecule can get into the plant," he suggests.

Next year's trial will look more closely at application technique to see whether it can be improved to help reduce total nitrogen further. "The previous season we were getting 10t/ha yields with 140kgN/ha, but last year that wasn't adequate as I don't think there was enough nitrogen in the system after the wet winter. Hopefully we can drive down the nitrogen required – if we can start growing decent crops of wheat with 100kgN/ha, it's a game changer," he says.

David Aglen has pondered whether foliar nitrogen is working effectively for him in the North because of more favourable application conditions.

According to David Aglen, getting foliar urea into the plant is the difficult part. "I think using bubblejets or standard spray jets is hit and miss. Most of what you spray probably ends up on the ground so we're going to try hollow cone jets for a really fine, swirling mist around the plant.

"Anecdotally they work a lot better, giving fantastic coverage on the leaf. They're also cheap, but you do have to watch your timing with drift," he concludes. ■

Research roundup

From Theory to Field is part of AHDB's delivery of knowledge exchange on grower-funded research projects. *CPM* would like to thank AHDB for its support and in providing privileged access to staff and others involved in helping to put these articles together.

For more detail about this project, visit ahdb.org.uk/strategic-cereal-farms

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