Late nitrogen in wheat: better late than never? How late is too late?

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Take home messages
- Apply nitrogen early (stem elongation) for yield and later (head emergence) for protein
- Nitrogen decisions should be made as the season unfolds because a good finish can make all the difference
- Given the total amount of nitrogen applied to the crop and the soft finish, all treatments met APW specification for protein (above 10.5%)
- There was no significant difference in yield or protein between the different urea, UAN and liquid urea
- There was also no significant difference between the 25 kg N/ha and the 50 kg N/ha rates for yield, however protein was increased

Background
When it comes to nitrogen management there is no silver bullet. The way the crop responds to inputs depends on a range of factors including available nutrition, soil moisture, timing of application and of course seasonal conditions. These issues all need to be considered when developing a nitrogen strategy.

Improving the efficiency of nitrogen usage is a challenge that farmers are facing across the globe as this is a crucial factor that affects the yield and protein levels of cereals. Too much nitrogen may increase the susceptibility of the crop to disease pressures and inefficient water use through the production of excess canopy. However, too little nitrogen applied to a crop results in stunted yields, lower or limited protein levels and a decline in profitability. This relationship is shown in Figure 1 below.

Figure 1. Grain yield (t/ha) and protein concentration (%) from 10 wheat varieties with varying rates of applied nitrogen (Brill et al, 2012).

This is not new information but perfecting the rate, timing and source of nitrogen applications to achieve the yield and quality goals of different crops is an ongoing challenge and so it remains a key research priority as nitrogen management.

Method
This particular project has focussed on wheat, testing how late we can apply nitrogen to achieve the highest protein and yield in a milling variety. The four timings of nitrogen application were GS32 (stem elongation), GS39 (flag leaf), GS55 (50% head emergence) and GS70 (end of anthesis). This trial also looked at varying the rate (25 kg N/ha and 50 kg N/ha) and product used (urea, UAN and liquid urea). The variety used in this trial was Forrest, an APW milling wheat that requires a minimum protein of 10.5%. While the 2013 growing season had an ideal wet spring, in a dry spring this protein requirement is at risk of not being met. Also during a dry finish, screenings are often seen to be higher; this puts the crop at risk of being downgraded.
The trial was located at Westmere. Prior to the GS32 treatment the “usual” grower treatments were applied by the farmer; in this case the paddock had 75 kg N/ha and this was applied at sowing and up to GS29.

**Results**

**Timing**

Our results show that time of application has a large impact on the yield and grain protein. Figure 2 illustrates that there is a statistically significant difference in yield between GS32 (stem elongation) and GS70 (post anthesis) nitrogen applications. Around GS32 the number of grains per ear is being determined so limiting N at this point will limit yield; nitrogen applied at GS55 or later will contribute almost exclusively to grain protein and have little effect on yield.

![Figure 2. Effect of application of N at varying growth stages on wheat yield and protein. Error bars represent LSD at p<0.05.](image)

With the 2013 season having such a wet spring the opportunity for farmers to put out a late application to boost protein was certainly an option, however if the spring “cut out” and didn’t finish the way it did, then late N applications can be risky as crops are more likely to finish early and waste that N.

**Rate**

Figure 3 below shows the effects of the two different nitrogen rates applied on yield and protein. Despite being twice the rate, there was no yield difference at 50 kg N/ha compared to 25 kg N/ha. There was however a significant difference in grain protein, with an average protein of 11.65% at 50 kg N/ha, compared to 11.1% at the lower rate.

![Figure 3. Effect of the two different rates of nitrogen on wheat yield and protein. Error bars represent LSD at p<0.05.](image)

The lack of increase in yield at 50 kg N/ha could be due to the paddock already having such a good N history over the 2013 season, so yield potential may have been reached, therefore any excess nitrogen was directed into grain protein.

**What does this all mean for you?**

The 2013 growing season gave us a textbook spring in terms of rainfall and mild weather so there was opportunity for growers to apply additional late nitrogen and get results. Proteins were high across the region which indicates that yield potential was being met; however yields in some areas were reduced in comparison to previous years.
This may not have been directly associated to lack of N and may have been due to other pressures such as waterlogging, poor weed control or late sowing.

This trial looked into three different forms of nitrogen: granular urea, UAN and liquid urea. The data indicated there were no significant differences between the three products. This may be attributed to the season being so forgiving, allowing for the plant to utilise all the applied nitrogen, regardless of the form.

In terms of comparing liquid N and urea, there are a number of factors that farmers still need to take into consideration, granular urea is by far the cheapest form of N; however granular urea can show an increase in losses via volatilisation when compared to liquid N, being due to needing rain to be taken up by plant roots. Nitrogen losses when applying granular urea are estimated to be around 10%.

Scorch is a problem to consider when applying nitrogen through a foliar spray, and despite not being an issue in this trial, it is still a concern that cannot be forgotten about. It is most commonly seen when using products such as Ammonium Nitrate solution, Ammonium Sulphate solution and UAN. To reduce the impact of scorch, there are several safety tips to abide by:

- Avoid application coinciding with frosts, both the day of application and the following day.
- Be aware of the soil moisture, it is wasteful to apply N that cannot be utilised if water is a limiting factor.
- Do not mix N with adjuvants
- Watch weather conditions - in particular wind more than 18 km/hr.

The results indicate that by applying N at GS32, yield is optimised and a later application at GS55 improves protein. There was a significant increase in yield at GS32 because at this stage the plant is undergoing stem elongation and thus determining the number of grains per ear, it is especially important not to be limited for nitrogen at this point.

The protein of the grain was significantly increased following a nitrogen treatment at GS55, this increase in protein is probably due the plant having the ear partially emerged, and the plant is putting its focus onto grain fill.

Previous research has indicated that there is a strong correlation between grain yield and protein. The general rule is that if protein is below 10.5% then it can be assumed that yield was also limited due to lack of N. All of the plots in this trial had proteins above 10.5%, which indicates yield was not limited due to lack of nitrogen. This is not surprising given the crop had already had 75 kg N/ha up to GS29, however, the crop wasn’t quite at yield potential until another 25 kg N/ha was applied during stem elongation.

The response to additional nitrogen in this trial was a result of the wet spring, however under the different circumstances of a dry spring the N response could have been significantly less. This is due to the plants lacking moisture during grain fill.

The results indicate that applying N at GS70, neither yield nor protein was increased. This was due to the plant beginning to senesce and being unable to utilise N.

Whilst it may be time saving to apply N upfront, this will result in a range of follow-up issues related to canopy management because upfront N will result in excess tillers. Therefore, there are some benefits to be had with a split application of N, such as limited tillers which may have better grain fill come end of the season, especially in the case of a dry finish. However, there are some risks associated with a split application. Issues such as a wet season, may prevent access to the paddock resulting in a later than ideal application or loss of application all together. The risk of leaving N application too late may result in tiller mortality, stunted crops in waterlogged paddocks, and loss of green leaf.

References

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