In-crop nitrogen timing and product choice for wheat

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Take Home Messages

- As a result of very poor seasonal conditions, there was no response to nitrogen applied to Yitpi wheat at either Rupanyup or Hopetoun in 2006, despite very low soil nitrogen levels.
- Delaying nitrogen application until after the end of tillering can allow a more accurate assessment of seasonal conditions to be made and money to be spent on nitrogen only if a response is likely.
- In 2006 growers taking this approach, delayed their nitrogen decisions past the early break that occurred in many parts of the Wimmera and Mallee, until seasonal indicators were more certain. As a result most did not apply any nitrogen to cereal crops and did not lose out on yield or quality

Background

Topdressing is becoming an increasingly important method of nitrogen management for cereal crops. It provides flexibility in that nitrogen can be delayed until more information is known about the season. In drought years, such as 2006, nitrogen could be deferred until 2007 to save on crop input spending in a very low yielding year. In better seasons multiple topdressings and higher rates can be used to provide the higher crop nitrogen requirements.

Previous GRDC trials conducted in the Wimmera and Mallee by BCG and FAR have shown the optimal time to topdress wheat (for yield, protein and profit) is after the end of tillering (GS30) to flag leaf emergence (GS39).

The product most widely used for topdressing in Victoria is still urea. UAN is becoming more available in Victoria, so this trial was designed to again test the response to in-crop nitrogen application as well as compare the performance of UAN and urea under alkaline soil conditions, which show greater losses of nitrogen from volatilisation than acidic soils.

Methods

This trial was conducted using a fully replicated (x4) randomised block design at the Hopetoun and Rupanyup trial sites.

Yitpi wheat was sown at Hopetoun on the 16th May and at Rupanyup on 18th May 2006 at 175plants/m^2 with 50kg/ha Granulock 10Z. Weeds were controlled at both sites throughout the season.

Nitrogen was applied at a rate of 40kgN/ha as either granular urea or UAN according to the growth stage timings in Table 1 - regardless of forecast rain events.

Table 1: Nitrogen product and application timings at Rupanyup and Hopetoun.

Treatment No.	Product	Timing
1	None	Control
2	Urea	100% GS30
3	Urea	100% GS30 + 7days (Rupanyup) 100% GS30 + 5days (Hopetoun)
4	Urea	50% GS30 + 50% GS37
5	UAN	100% GS30
6	UAN	100% GS30 + 7days (Rupanyup) 100% GS30 + 5days (Hopetoun)
7	Urea	100% GS37

Note: Total amount of nitrogen applied was 40kgN/ha.

Available soil nitrogen at the time of sowing was 33kgN/ha at Rupanyup and 27kg N/ha at Hopetoun.

The trial was split into two areas of interest:

- *Product Comparison For Volatilisation*: treatments 1, 2, 3, 5 and 6 were analysed separately to investigate the effects of urea vs UAN and the effects of a delay in rainfall after nitrogen application.
- *Nitrogen Timing Of Application*: treatments 1, 2, 4, and 7 have been analysed to study the effects of different timings of topdressed nitrogen.

Results

Yield: Product Comparison for Volatilisation

At Rupanyup, GS30 treatments were applied on 15 August, followed by 4mm of rain on 17 August and 1.5mm on 19 August. The GS30+7days treatment was followed by 10.5mm of rain on 24 August.

At Hopetoun GS30 treatments were applied on 11 August and GS30+5days on 16 August. The Hopetoun site received only 2mm on 17 August and then no further rainfall until 16.5mm on 6 September.

There was no significant yield response to applications of 40kgN/ha at either trial site. The treatments did not yield higher than the control regardless of the choice of product or the number of days without rainfall after application.

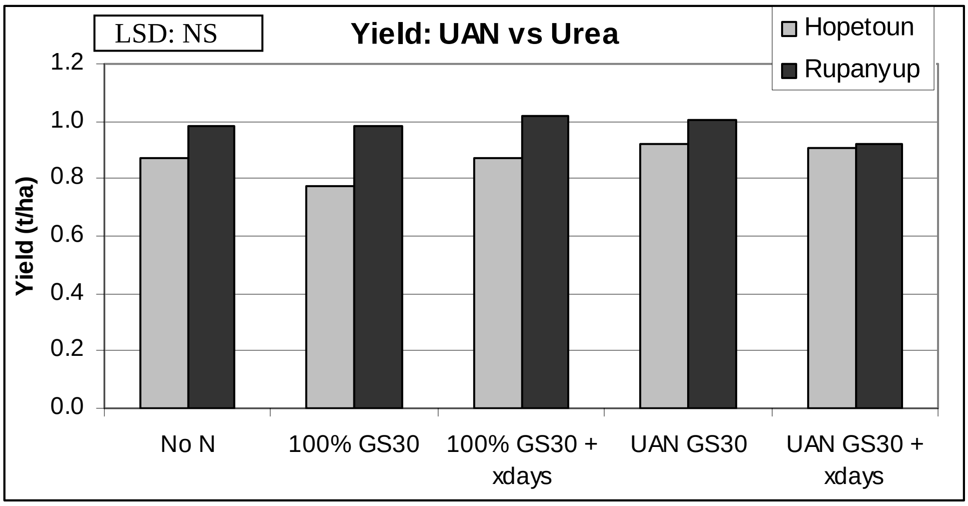

Figure 1: Wheat yield at Rupanyup and Hopetoun after application of 40kgN/ha in-crop as urea or UAN.
Note: x days represents GS30+5 days at Hopetoun and GS30+7 days at Rupanyup.

Yield: *Nitrogen Timing*

There was no yield response to in-crop application of urea at either Hopetoun or Rupanyup – regardless of the timing of application.

The GS37 treatments were applied at Rupanyup on 18 September and followed by only 2.5mm of rain on 20 September. At Hopetoun the GS37 treatments were applied on 5 September and was followed by 16.5mm rain on 6 September.

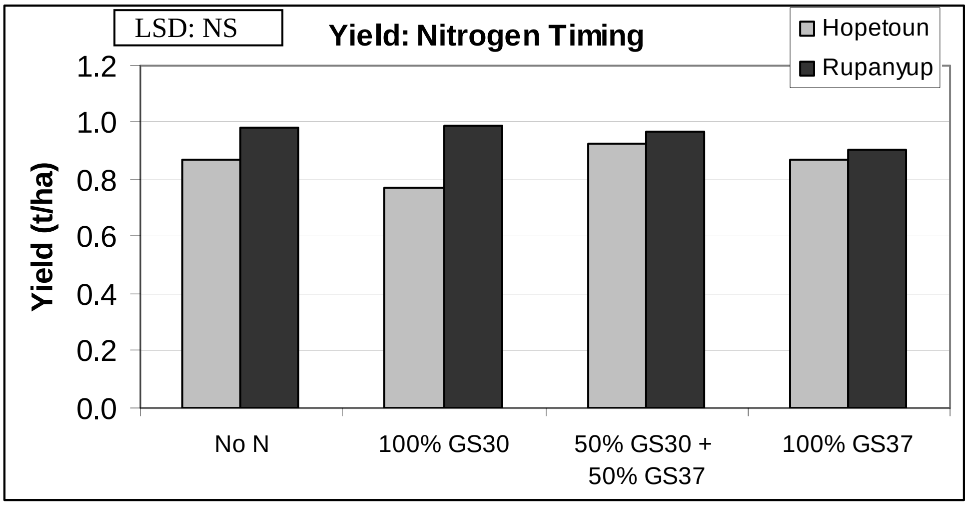

Figure 2: Wheat yield at Hopetoun and Rupanyup in response to 40kgN/ha topdressed as urea.

Head Number

The number of heads produced showed no significant ($p \leq 0.05$) response to the application of nitrogen at either Rupanyup or Hopetoun, regardless of product choice or timing of application.

Protein

There were no differences in protein as a result of topdressing 40kgN/ha regardless of nitrogen timing. However at Rupanyup there was a very small decrease in protein where UAN was the nitrogen source: average protein produced by urea treatments was 10.4% (product comparison trial treatments only) and the average from the UAN was 9.2% (lsd = 0.8; p=0.009).

Screenings

There was no effect on screenings at either trial site. Screenings were high at both sites with Rupanyup average 26.5% and Hopetoun average 11.3%.

Dry Matter Production

Two dry matter cuts were taken at Rupanyup, the first at booting (GS45) on 2 October, the second at anthesis/early grain fill (GS65) on 24 October.

The control treatment had produced significantly less dry matter by anthesis than where nitrogen was applied at GS30 (lsd = 0.78, $p \leq 0.1$). The same amount of dry matter was produced regardless of product choice between UAN and urea (Figure 3). There was no correlation between dry matter at anthesis and resulting yield.

In terms of timing of application, topdressing 40kgN/ha as urea at the end of tillering (GS30) produced significantly more dry matter than where urea was delayed until flag leaf emergence (GS37) or not applied at all (lsd = 0.70, $p \leq 0.05$).

At Hopetoun there were no differences in dry matter between the different timings of nitrogen application and nitrogen products.

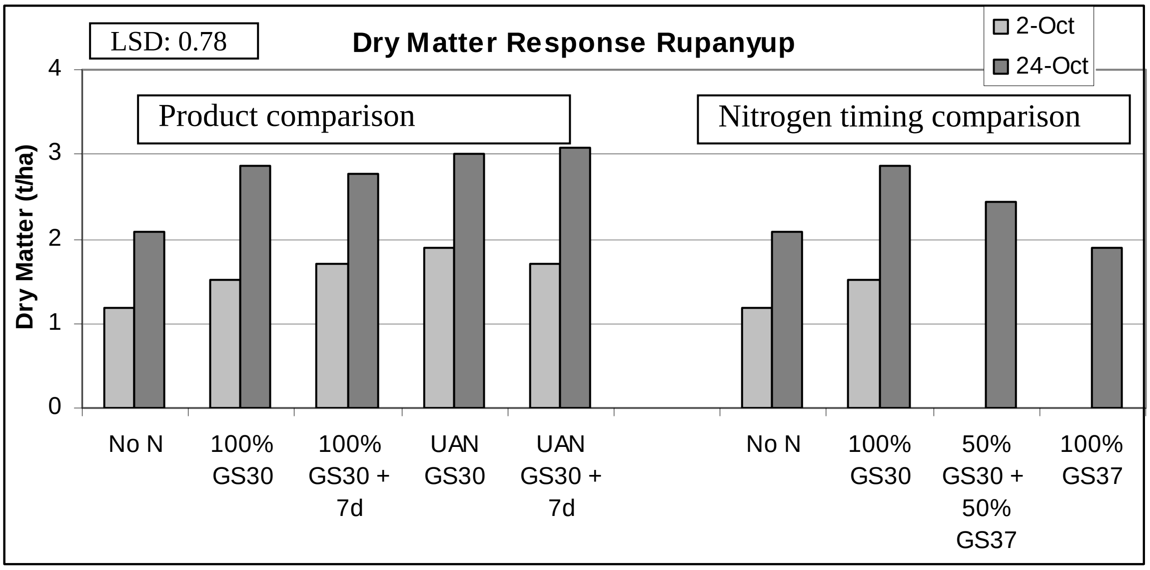

Figure 3: Dry matter production, Rupanyup.

Nitrogen Uptake

Comprehensive measurements of tissue nitrogen were taken at the Rupanyup site when dry matter was measured at booting and anthesis.

At booting, all of the treatments receiving nitrogen at GS30 contained significantly more nitrogen than the untreated control (lsd = 8.84, p=0.008), regardless of supply of nitrogen as urea or UAN. This trend continued through to anthesis (lsd 11.63, p=0.022).

Application of 40kgN/ha at GS30 significantly increased plant nitrogen content at anthesis above the split application of 20kgN/ha at GS30 plus 20kgN/ha at GS37, the control and the late topdressing timing (GS37) (lsd 9.37, p=0.002). The GS37 treatment was applied on 18 September and followed by 2.5mm rain on 20 September.

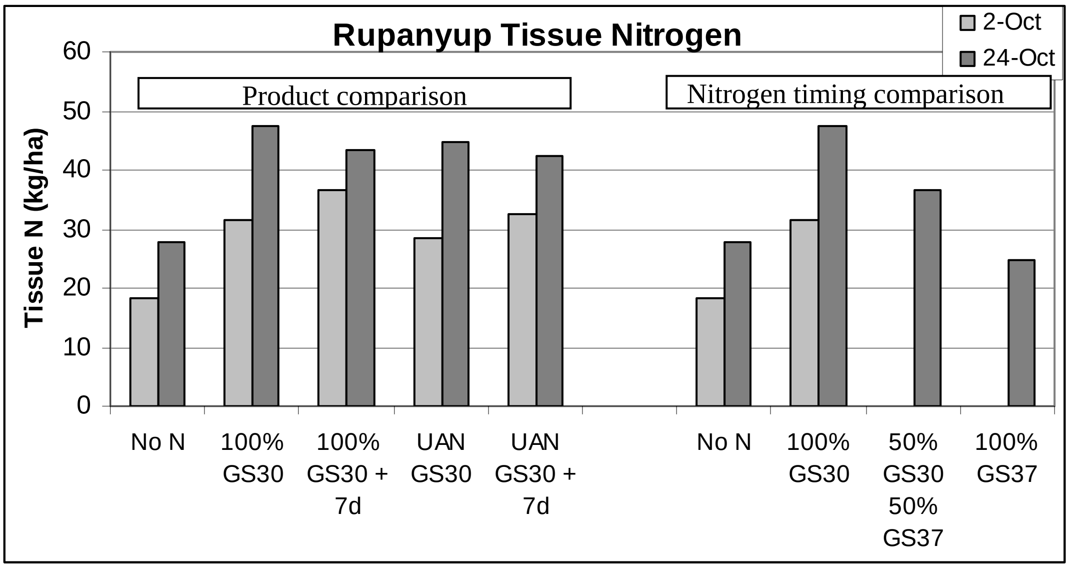

Figure 4: Tissue nitrogen content following application of 40kgN/ha, Rupanyup**.**

Interpretation

As a result of seasonal conditions there was no yield or grain quality response to the in-crop application of 40kg/ha nitrogen as either UAN or urea, at both the Hopetoun and Rupanyup sites. This was despite the crops at both sites, but particularly Rupanyup, coming under severe nitrogen stress after the end of tillering. Plants appeared yellow in colour and stunted in their growth as the trial received no extra nitrogen above the 33kg/ha already available in the soil at the time of sowing.

UAN produced lower protein at Rupanyup compared with urea. BCG also noted this trend at Marnoo in 2005. There were no differences in yield for the two products at both sites so this result is unusual and further investigation will take place in a more nitrogen responsive season.

An increase in dry matter and tissue nitrogen at Rupanyup suggest that the small amount of rainfall following application at GS30 (4mm) and GS30+7days (10.5mm) was enough for nitrogen uptake to occur but it seems there was no uptake of the nitrogen applied at GS37, due to lack of rainfall immediately after application and for the remainder of the spring. Conditions at Hopetoun seem to have prevented any nitrogen uptake with no dry matter response to applied nitrogen at this site, despite good rainfall immediately after the GS37 application. Use of UAN over urea did not increase the uptake of nitrogen, despite evidence that nitrogen can be taken up across the leaf surface.

Previous trials conducted by BCG in collaboration with FAR (GRDC project SFS 00015) have shown that delaying nitrogen application in wheat until stem elongation produces equal or better yields and superior grain quality (protein) to crops with the same amount of nitrogen applied at sowing.

These trials showed similar results in crop structure as previous trials with the early nitrogen (GS30) treatments producing more dry matter than late nitrogen (GS37) treatments and the control. Previous trial work has shown crops with more dry matter used more moisture than later nitrogen treatments and so ran out of stored soil moisture during the critical grain filling period. Late application of nitrogen helps to curb plant resources being expended on secondary tiller production and early leaf growth, thereby conserving moisture and nutrients for grain fill.

Commercial Practice

In difficult seasons, such as 2006, this approach to delayed nitrogen application as opposed to pre-drilling all nitrogen at sowing, allows flexibility to delay or remove expenditure on nitrogen if the season is not looking favourable. In 2006 many growers who took this approach did not apply any nitrogen to their cereal crops and saved considerable expense on nitrogen for no return.

In terms of product choice for in-crop application BCG trials at Marnoo in 2005 showed that it doesn't matter which product is used to supply the nitrogen, it is the timing that is most important. Product choice for on-farm application in 2007 should take into account area, machinery setup and capabilities and relative cost of each product per kilogram of nitrogen.

After such a difficult season in 2006, 2007 must be a recovery year. Seasonal forecasts for the Wimmera-Mallee have low accuracy until June-July so delay nitrogen input decisions until after this time, if possible, and tailor expenditure accordingly. Previous trial results suggest that the majority of nitrogen can be applied to wheat after the end of tillering (GS30-32), with the option for a smaller protein top-up at the flag leaf/early booting stage (GS37-45), without any impact on yield.

The knowledge gaps remaining after four years of BCG work on nitrogen timing in wheat are:

- *The effects of very low soil nitrogen*
  All previous sites have been above 43kgN/ha (0-70cm) at sowing. The 2006 Rupanyup site had a very low initial soil nitrogen content (33kg/ha) but seasonal conditions had a larger impact on yield than nitrogen. Very low soil nitrogen conditions still require further investigation with regards to their impact on yield and quality under delayed nitrogen application.

- *The position of the wheat crop in the rotation*
  All previous work has been conducted on the first wheat crop after a break crop. We have not studied the effects of delayed nitrogen on a second cereal crop in the Wimmera or Mallee as part of the previous four years of trials.

Despite these knowledge gaps nitrogen application to wheat in 2007 can still be offset until after sowing to save the $25/ha predrilling cost. In these situations nitrogen could be topdressed at early tillering for a spreading cost of approx $5/ha. This will be too early to have an accurate gauge of the season but will lower costs without the risk of affecting yield.