Canopy Management in the Northern Grains region – the Research View

by Guy McMullen NSW DPI

In the past much of the research on topdressing nitrogen (N) in northern NSW has focussed on the role of in-crop N to respond to seasons in which yield potentials have increased significantly due to above average rainfall conditions. In these situations research has shown that good responses can be achieved especially when good rainfall is received after N application (Australian Grain July-August 2007). Recently though there has been significant interest in the role of "canopy management" principles for crop production in the northern grains region.

What is canopy management?

The concept of canopy management has been primarily developed in Europe and New Zealand – both distinct production environments to those typically found in most grain producing regions of Australia and especially the northern grains region.

Canopy management includes a range of crop management tools to manage crop growth and development to maintain canopy size and duration to optimise photosynthetic capacity and grain production. One of the main tools for growers to manage the crop canopy is the rate and timing of applied fertiliser N.

The main difference between canopy management and previous N topdressing research is that all or part of the N inputs are tactically delayed until later in the growing season. This delay tends to reduce early crop canopy size but this canopy is maintained for longer, as measured by green leaf retention, during the grain filling period.

So can it work under Australian conditions – especially the shorter growing season of northern NSW? Results from southern regions have certainly showed some potential especially in areas with high yield potential and therefore higher N inputs but further research was required to test and validate the principles in northern NSW.

Research

Since 2006 trials have been conducted by a collaborative research group including NSW DPI, Northern Grower Alliance, AgVance Farming, and Nick Poole from the Foundation for Arable Research – NZ. This work funded by GRDC has focussed on the interaction between delayed N applications in high yielding crops on the Liverpool Plains.

Table 1. Nitrogen timings.

Treatment	At sowing (SB)	Stem Elongation (GS31)	Flag leaf emergence (GS39)
No N	-	-	-
Single Applications	100% N	-	-
	-	100% N	-
	-	-	100% N
Split Applications	50% N	50% N	-
	-	50% N	50% N
	50% N	-	50% N

To test if canopy management principles did improve crop performance in northern wheat crops, trials were established under overhead irrigation systems to supplement water supply at the critical growth stages when urea was applied to the soil surface. N was applied at 3 times through the season – combinations of seedbed (SB), during early stem elongation (GS31) or after flag leaf emergence (GS39). Details of the research sites and treatments are in Table 1 and 2.

Table 2. Overview of canopy management trials

	2006	2007	2008
Location	Caroona	Caroona	Spring Ridge
Sowing Date	27th June	14th July	29th May, 3rd July
Variety	Ventura	Ventura	EGA Gregory and Ventura
Starting Nitrate-N (0-90cm)	25 kg N/ha	74 kg N/ha	78 kg N/ha
Previous Crop	2005 Sorghum	2006 Sorghum	2007 Sorghum
Total N Applied	110 kg N/ha	140 kg N/ha	160 kg N/ha
In-crop rainfall	234 (123 mm irr.)	285 (150 mm irr.)	450 mm (incl. irr)

Further research by NSW DPI and Northern Grower Alliance is also assessing the role of different N fertilisers and measuring the losses of N due to volatilisation.

Results

From 2006 and 2007 the response to tactically delaying N until later in the growing season was relatively consistent for main to late sown, short season crops (cv. Ventura). In both years delaying or splitting fertiliser N did not result in significant grain yield increases compared to seedbed N. However, grain yield was maintained when N was split between SB and GS31. Delaying all N until after GS31 or splitting with GS39 applications resulted in lower grain yields but higher grain proteins.

Table 3 Influence of nitrogen timing on grain yield for main sown wheat cv. Ventura from 2006-2008.

Nitrogen Timing	Yield (t/ha)	Protein (%)	Screenings (%)
2006			
Nil	1.6	8.9	7.8
100% SB	3.7	11.8	7.7
100% GS31	3.3	12.5	6.6
100% GS39	2.3	14.2	5.3
50% SB + 50% GS31	3.7	11.7	7.3
50% GS31 + 50% GS39	3.3	13.0	6.6
50% SB + 50% GS39	3.5	12.1	5.7
LSD (5%)	**0.2**	**0.3**	**0.8**
2007			
Nil	2.6	11.8	3.8
100% SB	3.5	12.5	4.4

100% GS31	3.4	13.3	4.4
100% GS39	2.9	14.4	3.5
50% SB + 50% GS31	3.7	13.0	4.1
50% GS31 + 50% GS39	3.2	13.7	3.6
50% SB + 50% GS39	3.6	13.4	3.3
LSD (5%)	**0.2**	**0.3**	**0.7**
2008			
Nil	2.2	13.5	9.8
100% SB	4.7	13.4	8.5
100% GS31	4.4	14.4	8.9
100% GS39	3.4	15.1	9.9
50% SB + 50% GS31	5.4	13.5	9.0
50% GS31 + 50% GS45	4.3	15.0	8.8
50% SB + 50% GS45	4.8	13.6	9.6
LSD (5%)	**0.4**	**0.5**	**0.5**

In 2008 the responses when all N was delayed were much the same as in 2006 and 2007 with no advantage in delayed N (table 3). However, there was a 12% increase in grain yield when applied N was split between SB and GS31. Over the three years with late June or July sowings there has been an average 0.3 t/ha benefit to splitting N between SB and GS31 over the standard SB treatment (yield neutral in 2006, plus 0.2 t/ha in 2007 and plus 0.7 t/ha in 2008).

The results from the main sowing time in 2008 were encouraging but one of the key questions after 2006 and 2007 was what the response in early sown long season crops would be. In 2008 EGA Gregory was sown on the 29th May to assess these responses. The magnitude of the response was somewhat surprising. As in previous years the site was strongly responsive to N, in fact, canopy size as measured by crop dry matter showed a threefold reduction by delaying N until GS31 (figure 1). After flag leaf emergence and at flowering the canopy of the delayed treatments were still significantly smaller then the SB applied N. However, by crop maturity all delayed N treatments, except when all N was applied after GS39, had reached higher peak dry matter levels compared to the SB applied N treatment.

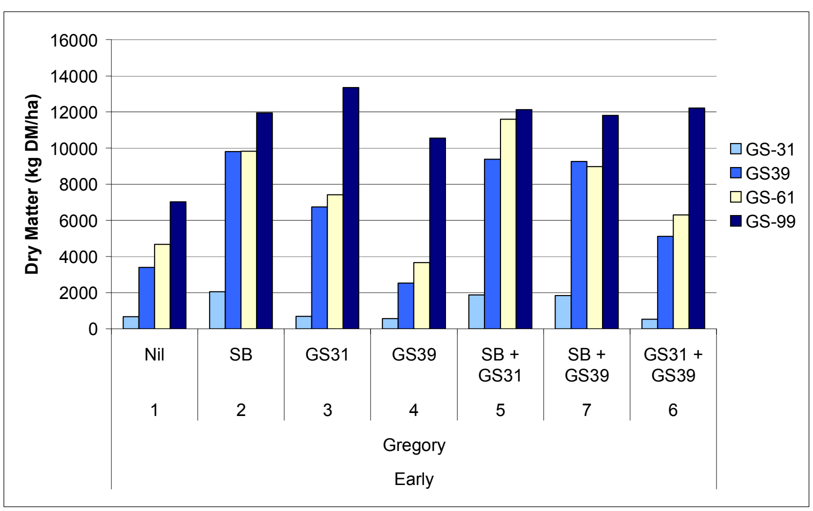

Figure 1 Effect of delayed N on crop dry matter (kg DM/ha) of early sown wheat cv EGA Gregory in 2008.

These large differences in canopy size translated into very strong grain yield and protein responses (figure 2). For the longer season EGA Gregory all delayed N treatments resulted in significantly higher grain yields compared to the SB applied N.

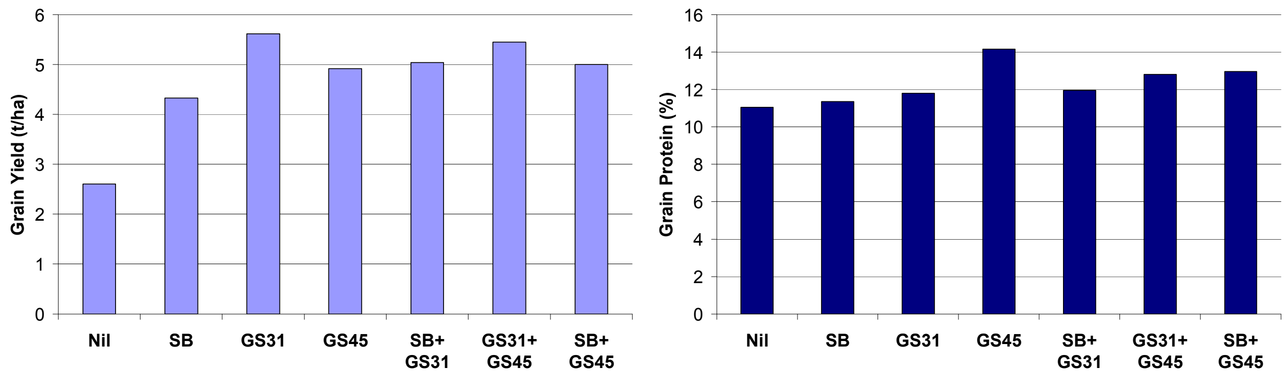

Figure 2 Effect of delayed N on grain yield and protein of early sown wheat cv EGA Gregory in 2008.

The highest yield was found when all N was delayed until GS31 with over 1 t/ha extra yield, a result that appeared to be linked to the crop canopy staying greener for longer during grain fill (figure 3). This increase in yield was accompanied by increased grain proteins for all delayed treatments, the greatest of which was when all N was applied after flag leaf emergence at booting (GS45).

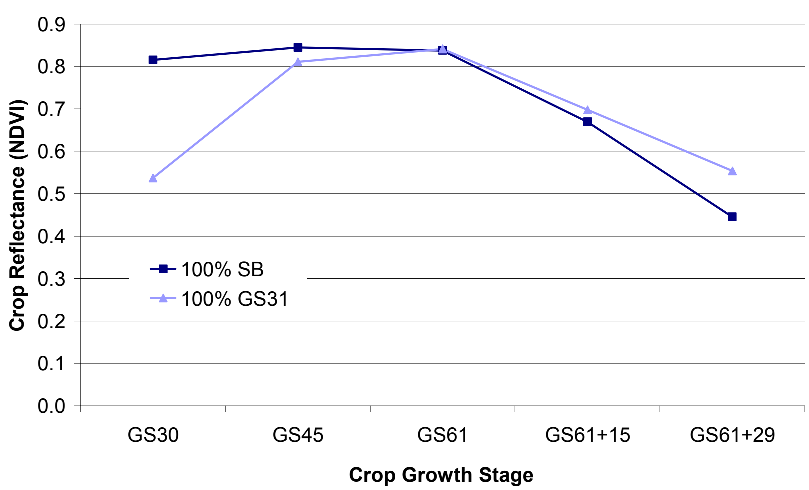

Figure 3 Effect of delayed N on crop reflectance (NDVI) of early sown wheat cv EGA Gregory in 2008.

N Volatilisation

The risk of N volatilisation remains a significant concern when applying in-crop N; particularly in northern NSW where lower rainfall incidence compared to southern regions and the presence of soil carbonates significantly increase the risk of N loss. Despite the risk factors being well understood there is little quantitative information available on the effect of soil properties, different N fertilisers and most importantly field conditions on potential losses of N. NSW DPI with the Northern Grower Alliance have been conducting lab based comparisons of the effect of differing soil properties and N fertilisers on the potential losses of N due to volatilisation.

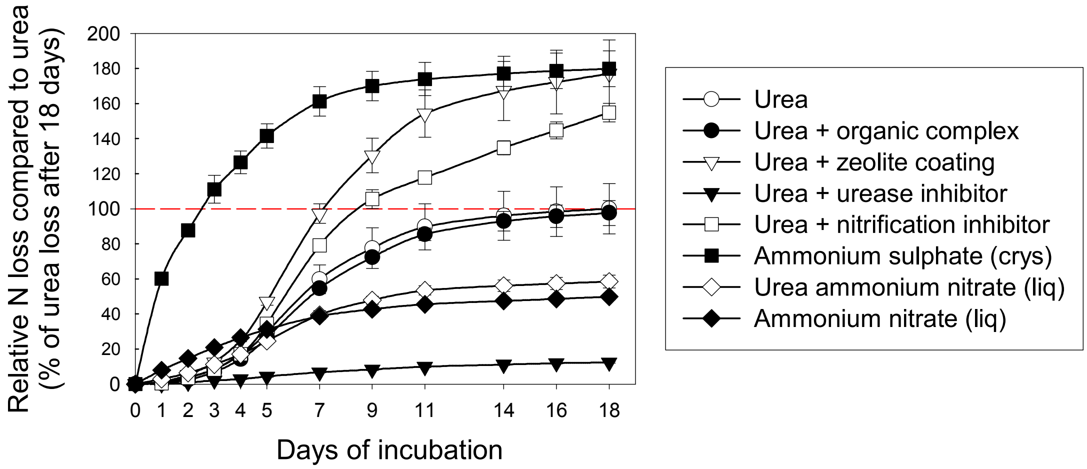

Figure 3 Cumulative volatilisation loss of nitrogen (N) applied as fertiliser to the surface of an alkaline soil containing 7% $CaCO_3$.

The lab based work has verified that the presence of calcium carbonates at the soil surface significantly increases the potential losses of N while some N fertiliser products can reduce the potential losses (eg urea ammonium nitrate liquid, liquid ammonium nitrate and urea treated with a urease inhibitor - GreenUrea®) (Figure 3). Field based estimates of volatilised N are to commence in the coming spring under a GRDC funded project.

Summary

Results from 3 years of supplementary irrigated research have provided important pointers for the use of canopy management principles in northern NSW. Tactically delaying N is a management system that allows flexibility to respond to seasonal conditions and manage climate variability. Research has shown that N fertiliser has been able to be delayed until stem elongation (GS31) without yield loss and usually with increased grain protein when conditions are suitable. This means that growers are able to apply a portion of the expected N requirement and then assess yield potential, as influenced by soil water and seasonal forecasts, later in the season and respond accordingly. To date the best results with this approach have been seen in early sown – long season varieties with high yield potential which are very N responsive with high N fertiliser inputs.

Further research in 2009 is looking at repeating these impressive responses and looking at the use of tactically delayed N in durum crops to improve yield and protein. Along with these primary aims the research group is also looking at using crop reflectance to assist in making N fertiliser decisions. To date crop reflectance (measured as normalised difference vegetation index – NDVI) at key growth stages has shown strong relationships to crop structure and yield.

A series of Soil 2 Grain workshops are planned to keep growers and advisors up-to-date with the latest results, techniques and guidelines from the GRDC funded project (SFS 00017) on Canopy Management and Disease Management in cereal crops. In the northern region a workshop is planned for the 21st July 2009. For further information please use the contact details below.

Canopy Management – The Commercial View

By Peter McKenzie, Agronomist – AgVance Farming, Quirindi.

Agricultural producers are constantly pressured by the cost/price squeeze and the need to maximise dollar return on inputs is an invariable part of farming. Canopy management is viewed as a tool to maximise plant water use and to try to ensure adequate soil moisture reserves for grain fill. It means many different things to different people, but by far the most popular view of canopy management in Australia, is manipulation of nitrogen application to alter plant biomass throughout the growing season. With fertiliser, particularly nitrogen, being one of the largest input costs in growing a crop on the Liverpool Plains, it stands to reason that we should be pushing the boundaries of maximising the grain produced, per unit of nitrogen applied. When starting a season with a full profile of moisture you can apply nitrogen with a degree of confidence of achieving the predicted yield. However adverse seasonal conditions will still result in excess application of nitrogen. When starting the season with less then a full profile, the harvested yield can vary by up to 5 t/ha which begs the question… 'Can we adapt southern canopy management principles to the northern cropping region?'

<u>Where does it fit for us?</u>
Based on the results of three years trials carried out by AgVance Farming, NSW DPI and NGA under the watchful eye of Nick Poole (FAR, New Zealand) it was concluded that delaying all nitrogen until Z30-31 had a detrimental effect on main season wheat plantings. The treatments where all of the nitrogen was applied up front, or split 50:50 (between planting & Z30-31) was where yield was maximised. NSW DPI/NGA demonstrated in one trial last season this may be different for longer season varieties, but this still needs to be proven over a number of years.
Based on the last three season's research, my current management approach is to establish a target yield level we believe we can achieve based on some back of the envelope water use efficiency calculations, using available moisture and predicted rainfall for the up coming season.
Generally a full profile of moisture receives sufficient nitrogen up front to provide the entire crop requirement to the predicted yield level. If in the event yield potential is higher due to favourable seasonal conditions, there is generally opportunity to apply small amounts of nitrogen later to increase yield as the season progresses but this usually isn't necessary. In a lower moisture profile situation, my approach is to apply nitrogen at a rate less than the target yield level requirement and top the nitrogen up later in front of rainfall, as opportunities present themselves. This requires careful planning and preparation on the grower's behalf, in order to take advantage of impending rainfall, sometimes in short timeframes. The 50:50 split application of nitrogen extends the period that nitrogen can be applied through the season without the 'cliff face' drop in yield if nitrogen isn't applied at precisely Z30-31. Effectively it improves the margin of error available to the grower if rainfall isn't forthcoming at Z30-31.
Where growers are set up for and using precision agriculture, I apply a 70:30 approach when there is a full soil moisture profile and a 50:50 approach where soil moisture is likely to be limiting. This is where a proportion of the predicted nitrogen requirement is held back until after NDVI imaging has taken place and nitrogen applied based on NDVI results. This also requires a high level of grower organisation and planning.

<u>The Limitations of Tactical Nitrogen Application</u>
The main limitation to such practices in the north is the ability to reliably apply nitrogen in front of a rain event, to enable roots to access soluble nitrogen in the root zone. An

analysis of rainfall events comparing Clare, South Australia and Wagga, NSW to Quirindi shows only 30% of the opportunities to apply nitrogen as our southern counterparts and the predictability of rainfall events more than 3 days in front of rain is very unreliable. Predicted rain fronts may pass without yielding a single drop therefore, dependably applying nitrogen throughout the season is risky. This becomes increasingly difficult as you head north and west of the Liverpool Plains to the likes of Moree and Walgett. Foliar nitrogen application has gained popularity in recent years however, this is only suitable for relatively low rates of nitrogen addition. In the likelihood of higher nitrogen input requirement, a system to apply nitrogen into the wet soil profile, post a rainfall event, at efficiencies that are economic, need to be devised to take full advantage of this system. To date, I don't believe these technologies have been developed for agriculture. As technologies such as NDVI imaging and paddock management in zones gain prevalence, the addition of nitrogen later in the crop cycle will become more and more relevant and will force the development of equipment to make such a system work.

While our traditional thoughts of canopy management are based on southern experiences, we are developing our own guidelines for the northern cropping zone. Based on solid trial work and in paddock experiences, the aim of improving the bottom line at the end of the season through manipulation of our most costly input is taking shape. Adoption of these techniques throughout the northern cropping zone would be further aided by development of efficient, in soil nitrogen application equipment.