4.7 CANOPY MANAGEMENT IN WHEAT (INVERLEIGH VIC)

Author: Nick Poole

Researchers: Nick Poole & Tabitha Armour (FAR, NZ), Wes Arnott & Rohan Wardle (Southern Farming Systems)

Location: SFS Inverleigh Research site

Acknowledgements:
The following trial is part of a new GRDC funded project (SFS 00015) examining the integration of the principles of disease management and canopy management in cereal crops. This trial had the objective of examining how the crop canopy was influenced by nitrogen rate and timing.

Summary:

- Results, though generated in the high rainfall zone, were influenced by extremely dry conditions up until mid October, at which point the season changed from a decile 1 to decile 3 - 4.
- The other key driver in this seasons canopy management trial results were the high soil nitrogen reserves present at sowing, 150kg/ha N in the top 60cm, with over 50% in the top 10cm.
- Under these conditions, there was a significant but small yield response (0.39 t/ha) to nitrogen fertiliser applied at the 50 kg/ha N, however this yield response was reduced to only 0.16 t/ha when a further 50 kg/ha N was added (zero N plots 4.88 t/ha).
- Creating the correct crop canopy size with the optimum plant population was more important than nitrogen timing in this season's trial.
- The optimum margin after nitrogen and seed costs were taken into account was generated from the higher plant population (189 plants/m^2) and the 50 kg/ha N level.
- Both computer models (the Sirius Wheat Calculator and APSIM) showed promise, but it should be emphasized that the accuracy is extremely dependent on obtaining the correct soil description characteristics.
- With high soil nitrogen reserves Yield Prophet (APSIM model) clearly indicated that the probability of exceeding a 0.5 t/ha yield increase from 50 kg/ha N was relatively small.
- Overall, the results illustrate the value of knowing how much nitrogen is in the soil and the importance of making sure that crop canopy size as determined by plant population is within the optimum range (150-200 plants/m^2 from the last three years of work).

Background:
Previous work in GRDC project SFS00006 illustrated that moving the timing of applied nitrogen later in the season to early stem elongation had two principal benefits in comparison to applications applied pre sowing:

Greater nitrogen utilisation since grain protein content associated with GS30-31 applications of nitrogen were higher (approximately 1%) than pre sowing applications.
Greater opportunity to assess the season's potential in light of the weather to date, as the main nitrogen application can be delayed until early September rather than applied in May.

Methods:
Mackellar wheat was sown on 9th June into a moist seedbed following Canola. Growing season rainfall (April – Nov) recorded at Inverleigh was 350 mm. The crop, which was established at two seedrates (76 & 189 plants/m^2), was treated with standard inputs, with the exception of nitrogen fertilizer, which was applied in accordance with the treatment list in Table 4-14.

Table 4-14: Nitrogen (Urea) Timing And Rate (kg/ha N) Applied To Mackellar Wheat

Treatment Timing	Growth Stage Description
Untreated	No nitrogen applied
50% N pre sowing – 9th June; 50% N GS31 –13th Sept	50% of N applied at pre-sowing and 50% at first node
100% N GS31 – 13 th Sept	All nitrogen applied at first node
100% N GS39 – 5th Oct	All nitrogen applied at flag leaf emergence on main stem
50% N GS31 - 13th Sept 50% N GS39 – 5th Oct	50% of N applied at first node and 50% at flag leaf

Each nitrogen timing treatment was applied at two different nitrogen rates**: 50 and 100** kg/ha N.

The trial also evaluated the performance of two computer based programmes designed to help growers make better decisions on input management particularly nitrogen, The Sirius Wheat Calculator developed in New Zealand and Yield Prophet an Australian commercial decision support tool that is based on the APSIM model developed at Toowoomba.

Results

i) a) Available Soil Nitrogen status (0-100cm)

At sowing:	June 9th	0-100 cm	148 kg/ha N (over 50% in top 10cm)
At GS25:	August 29th	0-100 cm	70 kg/ha N

i) b) Available Soil Water status

At sowing:	June 9th	0-60 cm	18mm

i) c) Growing Season Rainfall (April – November 2005) 350mm

Following canola, the initial soil nitrogen was relatively high for this site with approximately 150 kg/ha N available in soil in the 0-60cm profile. The high soil nitrogen reserve was still evident in the spring since there was little crop yellowing in the absence of applied nitrogen (despite testing that revealed only half remained from the sowing date assessment).

Of the 350ml of rain in the growing season 95mm fell in the month of October.

ii) Yield

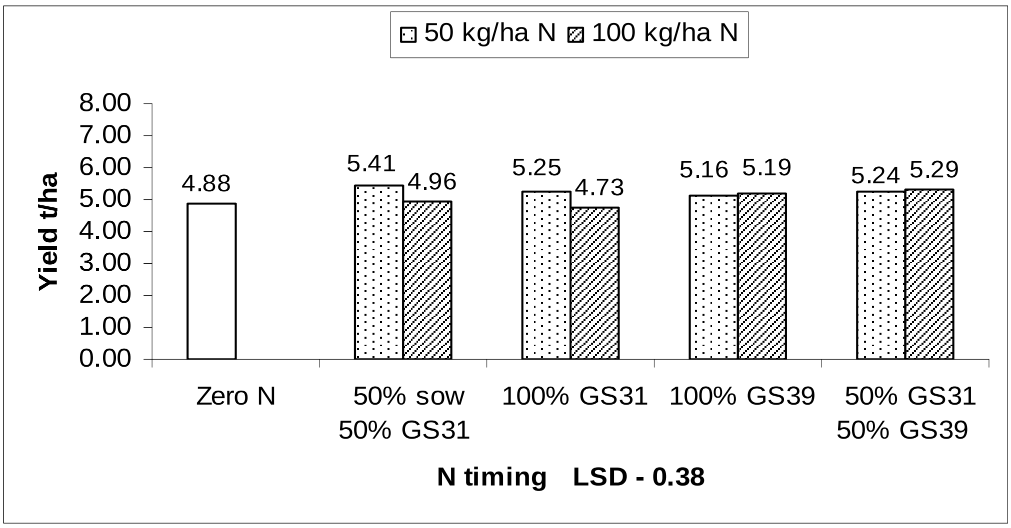
There was a significant yield response (0.39 t/ha) to nitrogen fertiliser applied at the 50 kg/ha N however this yield response was reduced to 0.16 t/ha when a further 50 kg/ha N was added (Table 4-15 andFigure 4-3).

Table 4-15: Yield Response (T/ha) To Nitrogen Fertiliser At Two Rates – Mean Of Four Nitrogen Timing Treatments

	No N	50 kg/ha N	100 kg/ha N
Yield (t/ha)	4.88	5.27	5.04
Difference to control	0	0.39	0.16

There was a significant yield advantage to nitrogen application, but averaging plant population revealed no significant differences due to nitrogen timing, though there was a slight decrease in yield associated with flag leaf only applications (0.25 t/ha lower yielding than the seedbed/GS31 split). With very high soil nitrogen reserves at sowing it is perhaps not surprising to see that there was no response to the higher rate of nitrogen. In addition, there was a trend to indicate that at the higher uneconomic rate of nitrogen, earlier timings depressed yield relative to later stem elongation timings.

Figure 4-3: Yield Response To Individual Nitrogen Timings At 50 & 100 kg/ha N (T/ha) – Mean Of Two Plant Populations



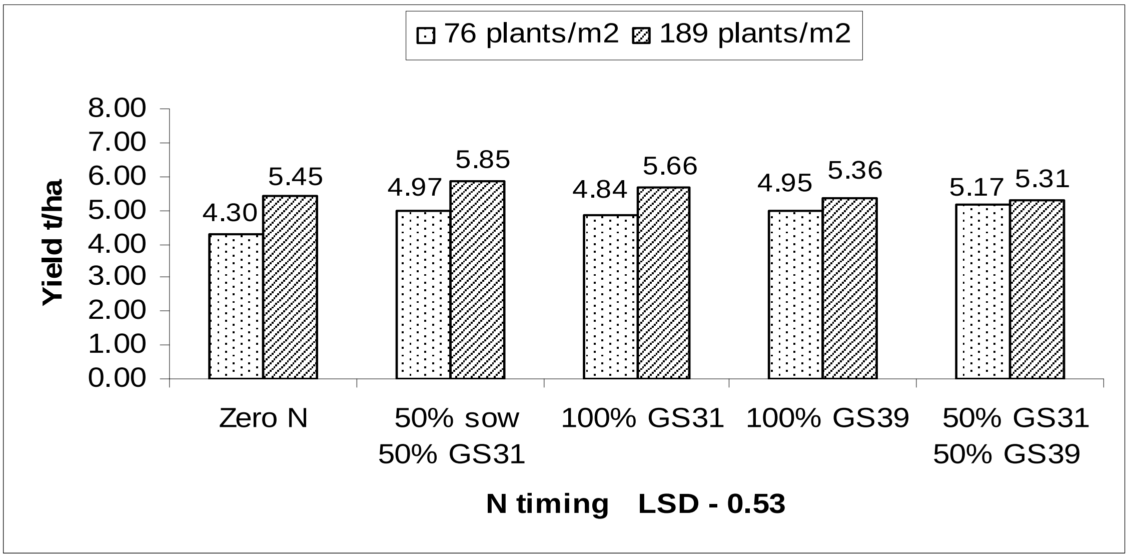
There was a significant yield increase (0.54t/ha) associated with the higher plant population of 189 plants/m^2 (Table 4-16) over the lower population of 76 plants/m^2.

Table 4-16: Yield Response (T/ha) To Different Plant Populations – Mean Of Four Nitrogen Timing And Two Nitrogen Rates

	76 Plants/m²	189 Plants/m²
Yield (t/ha)	4.84	5.38
Difference	0	+ 0.54

At the optimum nitrogen rate of 50 kg/ha N there was a significant yield advantage to the higher plant population of189 plants/m^2 (Figure 4-4). This yield advantage was significant at all nitrogen timings except when all the nitrogen was applied at flag leaf emergence (GS39) or the nitrogen was split between GS31 & 39. At the higher plant population (189 plants/m^2) the 50/50 split of seedbed nitrogen & GS31 was significantly higher yielding than all the nitrogen delayed until flag leaf GS39. At the lower plant population there was no difference in yield due to timing.

Figure 4-4: Yield Response To Individual Nitrogen Timings (T/ha) At Two Plant Populations (76 & 189 plants/m^2) Based On 50kg/ha N Rate



Protein

When averaged over the two plant populations there was a significant increase in protein levels associated with the application of 50 kg/ha N (Table 4-17 & Figure 4-5). The figures for 100 kg/ha N look to be aberrant since a higher rate of nitrogen would have been expected to increase protein content, particularly since the 100 kg/ha N application was not associated with a yield increase.

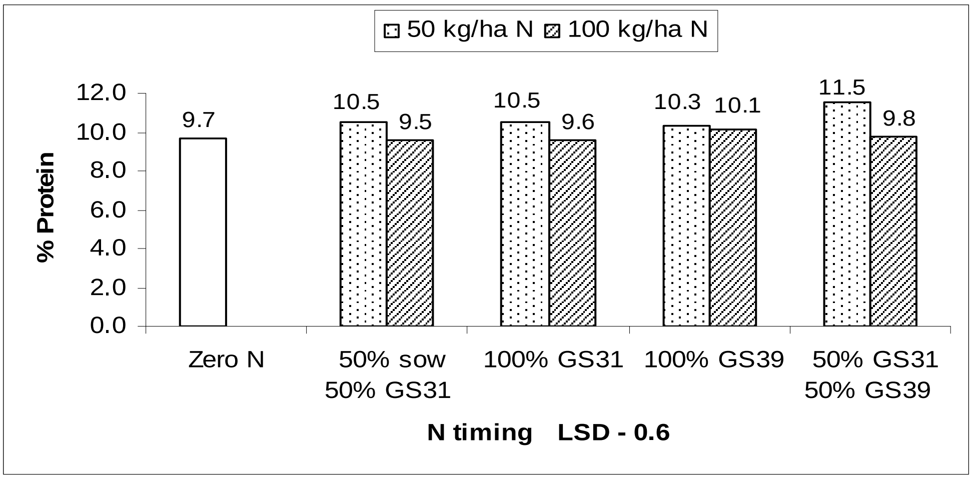
Table 4-17: Protein Response (%) To Nitrogen Fertiliser At Two Rates – Mean Of Four Different Nitrogen Treatments

	No N	50 kg/ha N	100 kg/ha N
Protein %	9.7	10.7	9.75
Difference to control	0	+1.0%	+0.05%

At 50 kg/ha N there was a significant difference in protein levels due to nitrogen timing, with 50/50 split of GS31 & GS39 giving the highest grain protein.

Plant population was also noted to have a significant influence on grain protein with the lower plant population giving higher proteins, 76 plants/m^2 producing an average of 10.3% grain protein and 189 plants/m^2 giving 10% protein.

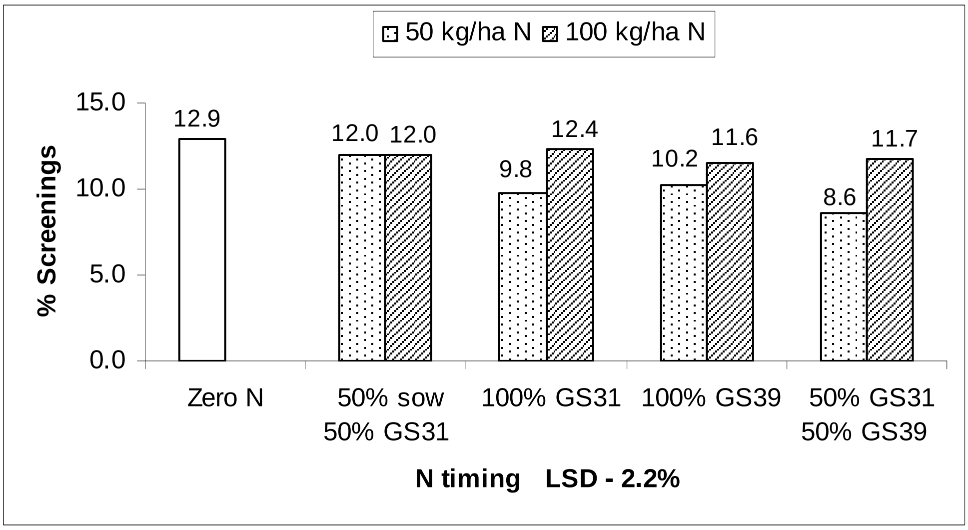
Figure 4-5: Protein Response To Individual Nitrogen Timings And Rates (Mean Of Two Plant Populations)



Screenings

There were significant differences in screenings due to nitrogen timing, particularly at 50 kg/ha N applied, where later nitrogen timing produced lower screenings (Figure 4-6).

Figure 4-6: Influence Of Individual Nitrogen Timings And Rates (Mean Of Two Plant Populations) On % Screenings



Test weight kg/hl
There was no significant difference in test weight due to treatment with all crops harvested being between 76 - 79 kg/hl

Crop Structure

Table 4-18: Influence Of Nitrogen Rate And Timing On Crop Structure (tillers/m^2, ears/m^2) And Yield

Nitrogen treatment		76 Plants/m^2		189 Plants/m^2	
Rate kg/ha N	**Timing**	**Tillers/m^2**	**Yield t/ha**	**Tillers/m^2**	**Yield t/ha**
0		419	4.51	593	5.26
50	50% Sow / 50% GS31	396	4.97	649	5.85
50	100% GS31	432	4.84	598	5.66
50	100% GS39	397	4.95	459	5.36
50	50% GS31 / 50% GS39	465	5.17	640	5.31
100	50% Sow / 50% GS31	377	4.92	550	5.00
100	100% GS31	458	4.73	571	4.73
100	100% GS39	479	4.81	722	5.57
100	50% GS31 / 50% GS39	471	4.99	558	5.58
70	GS30-31 Sirius Wheat Calculator (New Zealand) *	482	4.90	654	5.62
Mean		**438**		**599**	
LSD			**0.53**		**0.53**
CV 7.4%					

Sirius Wheat Calculator
* The Sirius Wheat Calculator developed by Crop & Food Research (New Zealand) models the growth of the wheat plant and produces nitrogen recommendations (based on soil N, soil moisture status and daily weather data) that maximize the profitability of the crop. The Calculator is carried on a CD rom for use on individual PC's.

With the low plant population (76 plants/m^2) there was significantly less crop canopy in terms of shoot (tiller) numbers than there was at the higher population (189 plants/m^2), a feature that was clearly related to final yield. There were few clear trends due to nitrogen timing or rate, a fact that maybe related to the high soil nitrogen reserve.

APSIM "Yield Prophet" Prediction
This is an Australian model with a web interface that provides an objective indication of the likelihood that a crop will respond to nitrogen fertilizer again based on detailed knowledge of soil N, soil moisture and using weather data up to the report date. Probabilities of likely yield outcomes and response to nitrogen are based on data to that point in time and then the previous hundred year's weather data to give probabilities for future yield outcomes.

On the 29th August at the end of tillering GS25, Yield Prophet predicted a 50% probability of obtaining at least 4.0 t/ha based on decile 1 for rainfall (as dry as the driest 10% of previous seasons).

At this stage in the season it was predicted that the response to 50 kg/ha N would be less than 0.5 t/ha, making the economics of nitrogen application marginal bearing in mind the high soil nitrogen reserves at sowing. In October the season changed from decile 1 to decile 4 "effectively saving the day". At the end of October Yield Prophet was predicting yields of 4.5t/ha with no N applied and 5t/ha with 40 kg/ha N applied. The actual yields depending on the optimum plant population were 4.50 - 5.25 t/ha for the zero N plots and 4.85 – 5.85 t/ha (depending on plant population and N- timing) for those treatments receiving 50 kg/ha N.

Conclusions

The optimum margin after nitrogen and seed costs were taken into account was generated from the higher plant population (189 plants/m^2) and the 50 kg/ha N level. Applying more than 50kg/ha N (70 & 100kg/ha N treatments) was less profitable than the zero nitrogen plots. At the higher optimum plant population only two

treatments were more cost effective than the zero nitrogen plots, these were 50/50 split applied in the seedbed and at GS31 and the all the nitrogen applied at GS31 (
Table 4-19).

Table 4-19: Gross income $/ha for MacKellar wheat after nitrogen and seed costs (not including application cost) based on base cash price of $140/tonne for feed wheat

Rate	N application timing	Yield t/ha	Gross Income $/ha	Gross Income – urea & seed cost $/ha
76 Plants/m^2				
No N		4.51	631	620
50N	50% Pre sow / 50% GS31	4.97	696	632
	100% GS31	4.84	678	614
	100% GS39	4.95	693	630
	50% GS31 / 50% GS39	5.17	724	660
Mean (excluding zero N)		**4.98**		
100N	50% Pre sow / 50% GS31	4.92	689	573
	100% GS31	4.73	662	546
	100% GS39	4.81	673	557
	50% GS31 / 50% GS39	4.99	699	583
Mean (excluding zero N)		**4.86**		
70N	Sirius Wheat Calculator	4.90	686	602
189 Plants/m^2				
No N		5.26	736	714
50N	50% Pre sow / 50% GS31	5.85	819	**745**
	100% GS31	5.66	792	**718**
	100% GS39	5.36	750	676
	50% GS31 / 50% GS39	5.31	743	669
Mean (excluding zero N)		**5.55**		
100N	50% Pre sow / 50% GS31	5.00	700	573
	100% GS31	4.73	662	535
	100% GS39	5.57	780	653
	50% GS31 / 50% GS39	5.58	781	654
Mean (excluding zero N)		**5.22**		
70N	Sirius Wheat Calculator	5.62	787	691

Since results are based on feed wheat no account has been taken of % protein and screening differences generated. Cost of nitrogen as urea - $1.05/kg N. Seed including Raxil $250/tonne.

Note:
Application costs have not been included in the above calculations, growers should apply there own costs to these, the following are guidelines only

Pre sowing application costs - $30/ha
Top dressing - $7.5/ha
At sowing (Triple bin) - $ less than $5/ha

Commercial Practice
In this trial given the right plant population (from 3 years work 180 -200 plants/m^2) it was possible to grow 5.25 t/ha purely from the large soil nitrogen reserves, indicating yet again the importance of knowing what level of nitrogen is carried in the soil.