2.1.2 Defining guidelines for canopy management in wheat for the different climatic regions of southern Australia – July sown Mitre

Location: SFS Inverleigh Main Research site Project No. SFS00015

Funding Organisation: Grains Research and Development Corporation

Researchers: Nick Poole, Foundation for Arable Research, New Zealand and Lou Ferrier, Southern Farming Systems

Authors: Nick Poole and Lou Ferrier

Acknowledgements: Grains Research and Development Corporation for project funding and John Hamilton for provision of land.

Summary:
Late sown Mitre (July 4) produced yields in the range of 0.6 – 2.16 t/ha following Canola stubble. With soil nitrogen reserves of approximately 30kg/ha N (0-10cm) recorded pre sowing, applied nitrogen was detrimental in this trial, with 50 kg/ha N reducing yield by 0.09t/ha and 100kg/ha N reducing yield by 0.23 t/ha. These figures disguise more detrimental yield reductions with seedbed nitrogen applications and no effect from stem elongation timings applied at GS31-39.

Whilst later nitrogen timings applied at stem elongation produced slightly higher yields than the zero nitrogen plots, there was no statistically significant difference, in addition there was no increase in protein levels over the zero N plots. Both facts suggested that the stem elongation nitrogen was not taken up since a key attribute of these timings in the past has been the increased protein content. Seedbed nitrogen reduced yield dramatically and whilst it increased protein (1-2%) most of this effect is likely to have been due to the reduced yields. In conclusion nitrogen was detrimental to yield and since the seedbed N was taken into the plant its yield depressing effects was greatest. In contrast stem elongation applications were not taken up, since there was no rain following application on October 2nd and 17th. From a commercial standpoint it needs to emphasised that application at stem elongation can be reviewed at that stage whereas a seedbed N application cannot.

Seedbed nitrogen particularly at the higher plant population led to higher tiller numbers (recorded at GS33), however the same timings were also associated with greater tiller death compared to GS31 nitrogen since at harvest there was no advantage to seedbed N in ear number. One possible explanation for the detrimental yield effect of nitrogen in the seedbed maybe that in setting up the crop with higher ear number, the plant limits its compensatory ability to adjust at later growth stages with other yield components such as grains per ear or thousand seed weight.

Canopy density as provided by plant population had very strong influence on both yield and quality. 200 plants/m^2 produced significantly higher yields (1.19 t/ha versus 1.84 t/ha) and better quality (test weight, screenings and TSW) than 100 plants/m^2. Whilst protein was slightly lower due to yield dilution, margin generated from the denser canopy was on average $139/ha greater than that achieved with lower plant population. This result again emphasises the fact that crop canopy provided by plant

population in the range of 150 – 200 plants/m^2 is much better for creating tillers than it is by applying more nitrogen upfront.

Background & Objectives:

- To determine the interaction of nitrogen timing and dose with plant population in terms of yield, crop structure, predisposition to lodging and quality in the high rainfall zone.
- To determine the influence of nitrogen applied at stem elongation versus up front nitrogen on soil moisture content and dry matter production.

Growing Season Rainfall (Apr – Nov): 235 mm
Soil Nutrition: Silty Loam, pH 5.8, Nitrate Nitrogen 30 mg/kg
Sowing Date: 4th July 2006
Sowing Rate: 100 and 200 plants / m^2
Harvest Date: 20th December 2006
Seed Treatment: Hombre

Methodology: The trial was sown into 2005 canola stubble and comprised of one cultivar (Mitre AH category) with two seeding rates, six nitrogen application timings, two nitrogen rates replicated four times. The trial was sown on July 4th.

Fertiliser Treatment: All plots sown with 100kg/ha granular Cu and Zn. Each nitrogen timing treatment (urea) was applied at two different nitrogen rates: 50 and 100 kg/ha N (Table 1).

Table 1. Nitrogen timing and rate (kg/ha N applied)

Trt No.	Pre sowing	GS 30-31 (2/10/06) (pseudo stem erect – 1st node)	GS 37-39 (17/10/06) (flag leaf emerging on main stem)
1	Untreated	---	---
2	100% Nitrogen	---	---
3	---	100% Nitrogen	---
4	---	---	100% Nitrogen
5	50% Nitrogen	50% Nitrogen	---
6	---	50% Nitrogen	50% Nitrogen

Each nitrogen timing was applied at 50 and 100 kg/ha N.

Fungicide Treatment: A standard GS 32 & 39 fungicide application to keep the trial disease free to extend the crop canopy duration. Opus 250 ml/ha was applied at both growth stages.

Weed Control:
Earlier – Roundup and Goal, Pre emergent (4/7/06) – Spray Seed @ 2L/ha and Trifluralin @ 1.2L/ha, Post Sowing Pre emergent spray (5/7/06) – Dual Gold @ 250mls/ha and Diuron @ 500 mls/ha, 5/7/06 – Tigrex @ 500mL/ha.

Results:

i) Crop Structure

Plant populations were targeted to produce approximately 100 and 200 plants/m^2, the actual figures established were 100 and 194 plants/m2.

Recorded at GS33 higher plant population and seedbed nitrogen increased tiller number and as a result canopy density however it was only those increases produced as a result of greater plant population that were sustained to produce more ears/m^2 (Table 2).

Table 2. Influence of Nitrogen timing (seedbed and GS31) on tillers/m2 recorded at GS33 and ear number/m2 at senescence

Plant Pop.		Seedbed		GS31 N	
	N Rate kg/ha	Tillers/m2	Ears/m2	Tillers/m2	Ears/m2
100 Plants/m2	50	251	55	259	80.5
	100	263	68.5	294	87.5
194 Plants/m2	50	482	98	385	101
	100	501	98.5	308	94

ii) Yield

Influence of nitrogen rate and timing on yield

There was a significant decrease in yield associated with nitrogen application that was most pronounced at the higher nitrogen rate (table 2).

	No nitrogen	50 kg/ha N	100 kg/ha N
Yield (t/ha)	1.65	1.56	1.42
Difference to control	0	- 0.09	- 0.23

These yield means disguised considerable differences in yield due to nitrogen timing such that where nitrogen was applied at planting it had a strongly negative influence on yield but where applied at stem elongation GS30-39 it resulted in a neutral or slightly positive effect (figure 1). The slightly positive responses to nitrogen obtained from the stem elongation nitrogen applications were not significantly different to the untreated control. The lowest yields were associated with the highest nitrogen rates applied at the seedbed timing.

Influence of plant population on yield

Results consistent with previous years at the Inverleigh site were recorded in terms of plant population, illustrating that plant populations of approximately 200 plants/m^2 were significantly higher yielding than 100 plants/m^2. This influence of plant population was significant irrespective of nitrogen timing (figure 2).

	100 Plants/m2	194 Plants/m2	LSD
Yield (t/ha)	1.19	1.84	0.05
Significance of Difference			***

With later sowing the difference in yield due to nitrogen rate was stronger than in previous trials at the site established in June.

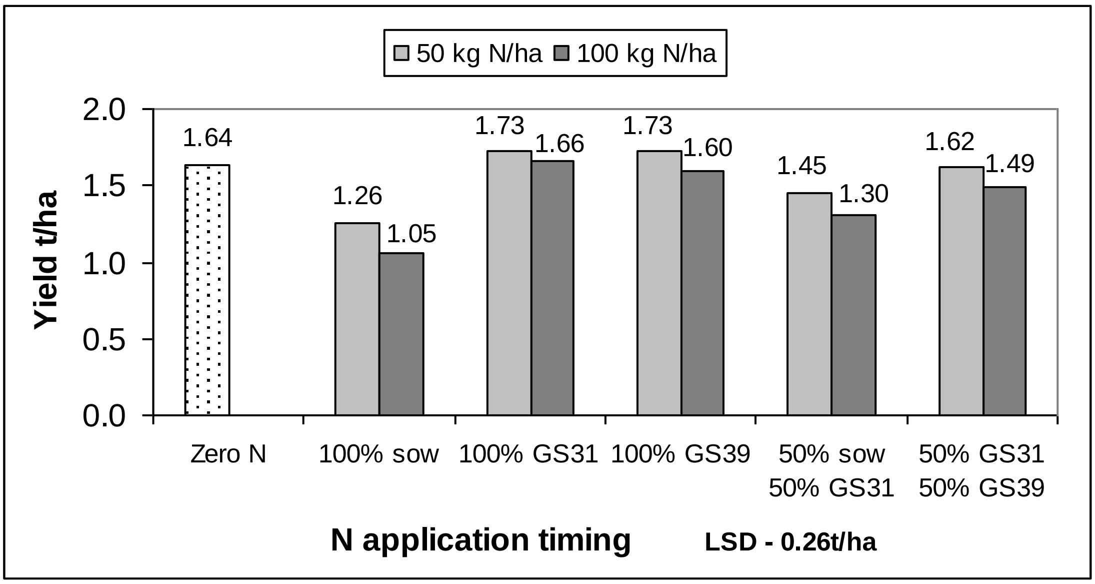

Figure 1: Influence of different nitrogen timings and rates on yield t/ha (mean of two plant populations) - Mitre wheat sown 4th July.

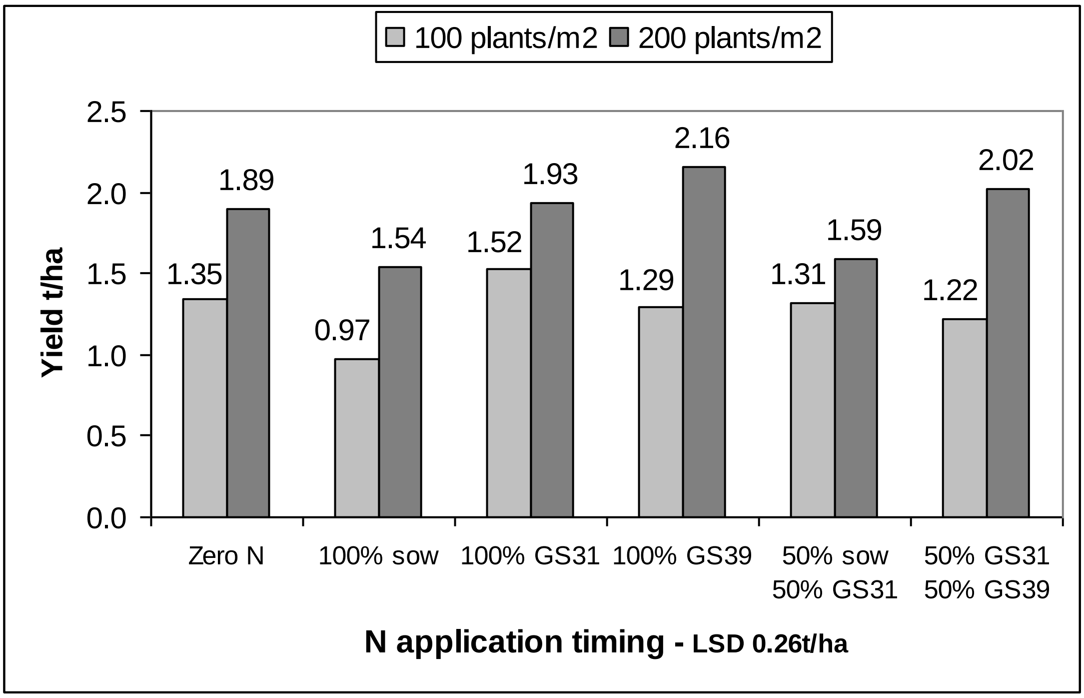

Figure 2: Influence of different nitrogen timings and plant population on yield t/ha (mean of two nitrogen rates) - Mitre wheat sown 4th July.

When all treatments were compared two factors stood out as having increased yield in this July sown wheat, increasing plant density from 100 plants/m^2 to 200 plants/m^2 and moving nitrogen timing from seedbed to stem elongation, however none of the stem elongation nitrogen treatments were higher yielding than the zero N (figure 3). Therefore it suggested that later nitrogen was less detrimental to yield than early seedbed nitrogen. In part this result may have been due to reduced uptake of the later nitrogen doses, since protein levels did not indicate higher grain protein levels in the stem elongation timings than in the zero nitrogen plots. In contrast previous seasons results normally reveal higher protein levels from later nitrogen applications (figure 4).

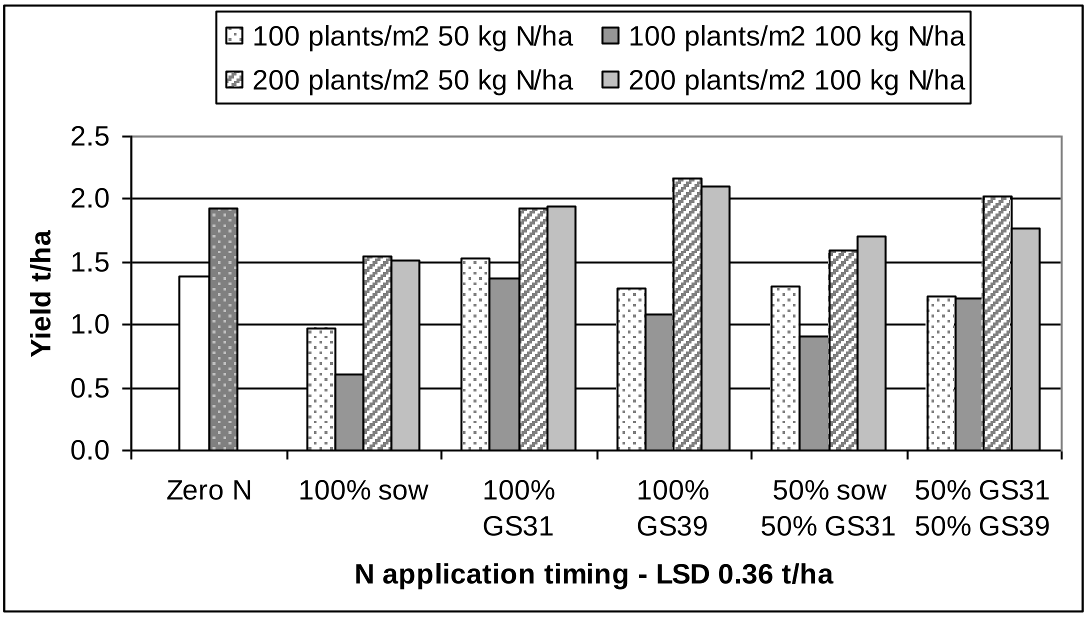

Figure 3: Influence of different nitrogen timings, nitrogen rates and plant population on yield t/ha - Mitre wheat sown 4th July.

iii) Quality

Treatment effects were evident in many aspects of quality, in particular protein (figure 4), where the highest proteins were produced by the seedbed applications. This result is correlated to much lower yields associated with these treatments.

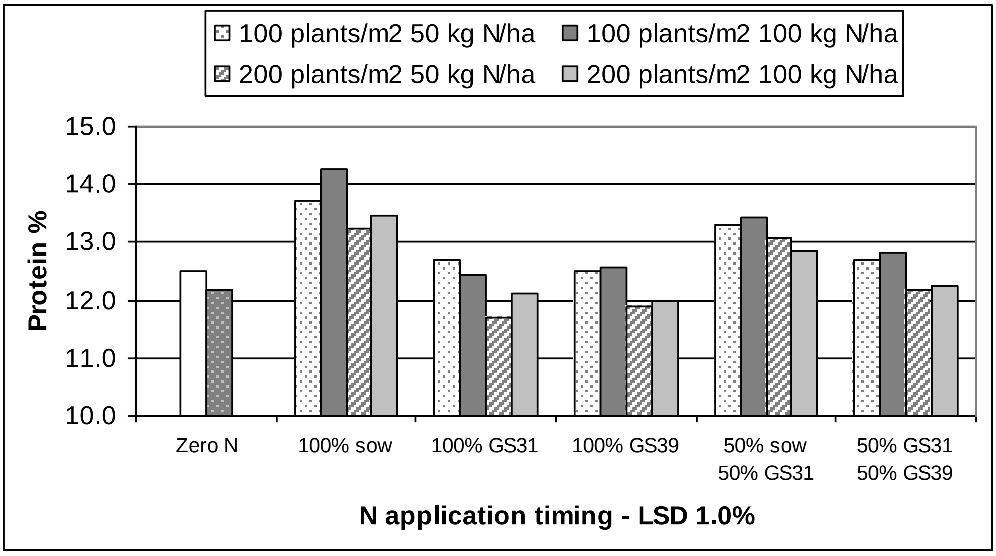

Figure 4: Influence of different nitrogen timings, nitrogen rates and plant population on % Protein - Mitre wheat sown 4th July.

There was little evidence of nitrogen uptake from the stem elongation treatments since protein levels were no higher than the untreated control. This result is unusual based on previous results but not unexpected this season since no rainfall fell following either GS31 or GS39 nitrogen applications in October.

Treatment, particularly plant population influenced screenings (figure 5), thousand seed weight and test weight, all three parameters increasing as plant population moved from 100 plants/m^2 to 200 plants/m^2

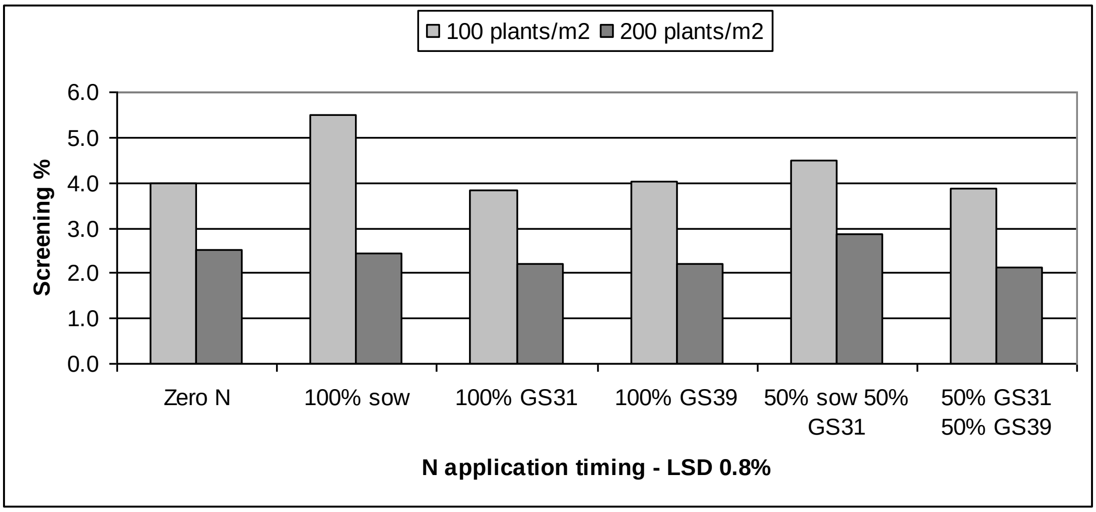

Figure 5: Influence of different nitrogen timings and plant population on % screenings (mean of two nitrogen rates) - Mitre wheat sown 4th July.

Conclusions

The extremely dry season with little or no rain after mid September reduced yield preventing any response to applied nitrogen. Later application of nitrogen applied at stem elongation were not taken up by the crop and as a consequence had less detrimental effect on yield in comparison to upfront seedbed N applications. Plant population with this July sown crop had a profound effect on its yield performance with 200 plants/m^2 significantly out yielding 100 plants/m^2. As a consequence of these interactions, yield and margin was optimised with zero N plots at the higher plant population (Table 3).

Table 3. Influence of different nitrogen timings, nitrogen rates and plant population on Yield t/ha, % Protein, Thousand seed weight (g), % Screenings 2.2mm, Test weight kg/hl and margin $/ha (after deduction of nitrogen and seed costs)

Plant pop	N rate	N timing	Yield t/ha	Protein %	TSW g	Screenings %	Test wt kg/ha	Margin $/ha
100	50	Zero N (Control)	1.35	12.2	32.0	4.3	73.0	287
		Seedbed	0.97	13.7	30.6	5.6	69.6	142
		GS30-31	1.52	12.7	28.9	4.1	71.7	265
		GS37-39	1.29	12.5	32.0	3.6	73.0	208
		Seedbed + GS30-31	1.31	13.3	29.5	4.4	71.9	212
		GS30-31 + GS37-39	1.22	12.7	32.2	3.9	73.0	185
	100	Zero N (Control)	1.40	12.7	31.5	3.7	73.4	302

		Seedbed	0.60	14.3	27.9	5.4	68.4	6
		GS30-31	1.36	12.4	31.4	3.6	73.9	174
		GS37-39	1.09	12.6	31.6	4.5	72.5	108
		Seedbed + GS30-31	0.91	13.4	31.2	4.6	71.0	67
		GS30-31 + GS37-39	1.20	12.8	30.4	3.9	72.6	126
200	50	Zero N (Control)	1.89	12.2	32.8	2.5	76.2	**403**
		Seedbed	1.54	13.3	31.8	2.0	75.2	271
		GS30-31	1.93	11.7	31.3	2.4	75.6	346
		GS37-39	2.16	11.9	33.0	2.2	76.4	385
		Seedbed + GS30-31	1.59	13.1	31.8	2.3	74.3	271
		GS30-31 + GS37-39	2.02	12.2	30.5	2.1	76.0	351
	100	Zero N (Control)	1.95	12.1	32.0	2.6	76.4	**417**
		Seedbed	1.51	13.5	33.2	2.9	74.9	207
		GS30-31	1.95	12.1	34.4	2.0	76.4	304
		GS37-39	2.11	12.0	30.7	2.3	75.3	323
		Seedbed + GS30-31	1.70	12.9	32.5	3.5	75.0	236
		GS30-31 + GS37-39	1.77	12.3	33.8	2.2	77.3	242
LSD								
[Within Seed rates, Control v Trt]			0.32	0.6	2.7	1.0	2.2	
[Within Seed rates, Trt v Trt]			0.37	0.7	3.2	1.2	2.5	
[Other Comparisons, Control v Trt C v T]			0.31	0.9	4.5	0.9	2.1	
[Other Comparisons, Trt v Trt]			0.36	1.0	4.6	1.1	2.4	
Significant Interaction Contrasts			nil	nil	Srate x Nlateness 5% sig.	nil	Srate x Nlateness x Nsplit 5% sig.	

Grain price based on AH category base price of $247/t minus $30/t for freight was adjusted to take account of protein and screenings. Cost of nitrogen as urea - $1.10/kg N. Seed including Raxil $250/tonne.
Note: Application costs have been included in the above calculations based on,
Top dressing - $7.5/ha
Wheeling damage has been included for any nitrogen treatment applied at GS39 with yields reduced by 2.5%.

A second trial that was not assessed in such detail as the above trial was based on Mackellar which was sown 19th May. The details of this trial are presented below however the objectives are identical to those above and are therefore not presented to the same degree of detail.

Title: Protocol 3a – Defining guidelines for canopy management in wheat for the different climatic regions of southern Australia – May sown Mackellar

Location: Beds F51 – F80 SFS Inverleigh Main Research site Project No. SFS00015

Funding Organisation: Grains Research and Development Corporation

Researchers: Nick Poole, Foundation for Arable Research, New Zealand and Lou Ferrier, Southern Farming Systems

Authors: Nick Poole and Lou Ferrier

Acknowledgements: Grains Research and Development Corporation for project funding and John Hamilton for provision of land.

Summary:
Early sown Mackellar (May 19th) produced yields in the range of 2.84 – 4.20 t/ha, despite poor crop establishment. Despite these yields there was no yield response to applied nitrogen, indicating that the soil nitrogen reserves of approximately 30kg/ha N (0-10cm) recorded pre sowing were sufficient to grow the crop. Applied nitrogen in the seedbed and at GS31 did significantly increase protein content of the grain, though since the trial was carried out in feed wheat this was not reflected in the margins. The increase in protein was an indication that nitrogen uptake occurred since yields were almost identical to the zero N controls.

It was canopy density as determined by plant population that had the greatest influence on both yield and quality. 115 plants/m^2 produced significantly higher yields (3.15 t/ha versus 3.84 t/ha) and better quality (test weight, screenings and TSW) than 63 plants/m^2. Whilst protein was slightly lower due to yield dilution this did not influence margins, thus the denser canopy at 115 plants/m^2 was on average $140/ha greater than that achieved with lower plant population, a figure identical to that experienced with Mitre sown in July.

Background & Objectives:
Identical to those described for Protocol 3
Growing Season Rainfall (Apr – Nov): 235 mm
Soil Nutrition: Silty Loam, pH 5.8, Nitrate Nitrogen 30 mg/kg
Sowing Date: 19th May 2006
Sowing Rate: 100 and 200 plants / m^2 (targeted but not obtained due to poor establishment conditions and deeper sowing) actual averaged 63 and 115 plants/m^2
Harvest Date: 13th December 2006
Seed Treatment: Hombre

Methodology: The trial was sown into 2005 canola stubble and comprised of one cultivar (Mackellar feed wheat) with two seeding rates, six nitrogen application timings, and two nitrogen rates replicated four times. The trial was sown on May 19th.

Fertiliser Treatment: All plots sown with 100kg/ha granular Cu and Zn. Each nitrogen timing treatment (urea) was applied at two different nitrogen rates: 50 and 100 kg/ha N (Table 1).

Trt No.	Pre sowing	GS 30-31 (4/9/06) (pseudo stem erect – 1st node)	GS 37-39 (13/10/06) (flag leaf emerging on main stem)
1	Untreated	---	---
2	100% Nitrogen	---	---
3	---	100% Nitrogen	---
4	---	---	100% Nitrogen
5	50% Nitrogen	50% Nitrogen	---
6	---	50% Nitrogen	50% Nitrogen

Fungicide Treatment: A standard GS 32 & 39 fungicide (Opus 250 ml/ha) application to keep the trial disease free and extend the crop canopy duration.

Weed Control:
Spray Seed @ 2L/ha and Trifluralin @ 1.2L/ha 19th May, Post Sowing Pre emergent spray (5/7/06) – Dual Gold @ 250mls/ha and Diuron @ 500 mls/ha, 19th May, Axial 300ml/ha and Tigrex @ 750mL/ha 20th July.

Trial Results:

i) Yield
Influence of nitrogen rate and timing on yield
There was no significant influence of nitrogen on yield, indicating that the soil nitrogen reserves (recorded as 30 kg/ha N 0-10cm) were sufficient to satisfy the yield in yield in this trial. Increasing nitrogen from 50 kg/ha N to 100 kg/ha N only to lose money.

	No nitrogen	50 kg/ha N	100 kg/ha N
Yield (t/ha)	3.53	3.53	3.50
Difference to control	0	0	- 0.03

Nitrogen timing had no effect on yield irrespective of timing, thus there was no indication that seedbed nitrogen was anymore or less detrimental than stem elongation nitrogen (figure 1).

Influence of plant population on yield
Results were consistent with the later sown Mitre since the higher plant population was significantly higher yielding than the lower population. However it is important to emphasis that the actual plant populations were well below the target populations of 100 and 200 plants/m^2. Poor establishment resulted in actual populations that were considerably lower (63 and 115 plants/m^2 respectively). For comparison it is worth presenting the Mitre yields from July 4 sowing, illustrating the importance of early sowing in a season such as 2006.

Table 2. Influence of plant population on yield t/ha of separate trials at the same site (May 19th sown Mackellar and 4th July sown Mitre)

May 19	63 Plants/m2	115 Plants/m2	LSD t/ha
Yield (t/ha)	3.15	3.88	0.07
Significance of Difference			***
July 4	100 Plants/m2	194 Plants/m2	LSD
Yield (t/ha)	1.19	1.84	0.05
Significance of Difference			***

There was a significant interaction between plant population and splitting nitrogen (p=5%), which illustrated that split timings of nitrogen were less successful with the higher plant population, the reason for this result remains unclear (figure 2).

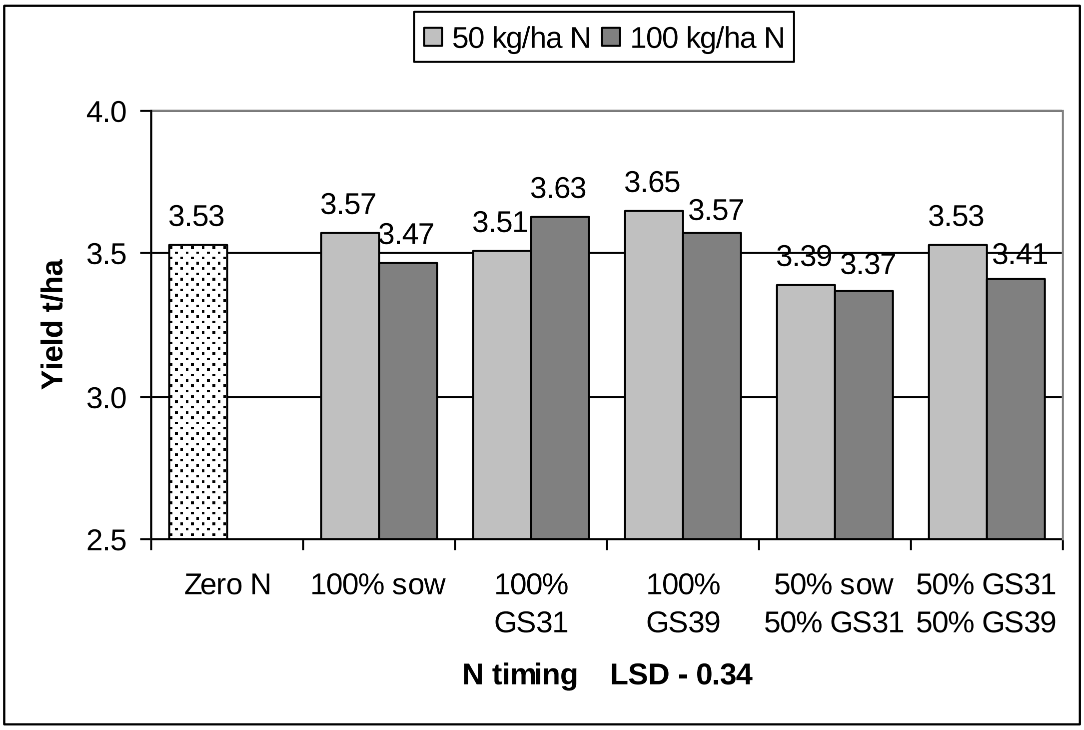

Figure 1: Influence of different nitrogen timings and rates on yield t/ha (mean of two plant populations) - Mackellar wheat sown 19th May.

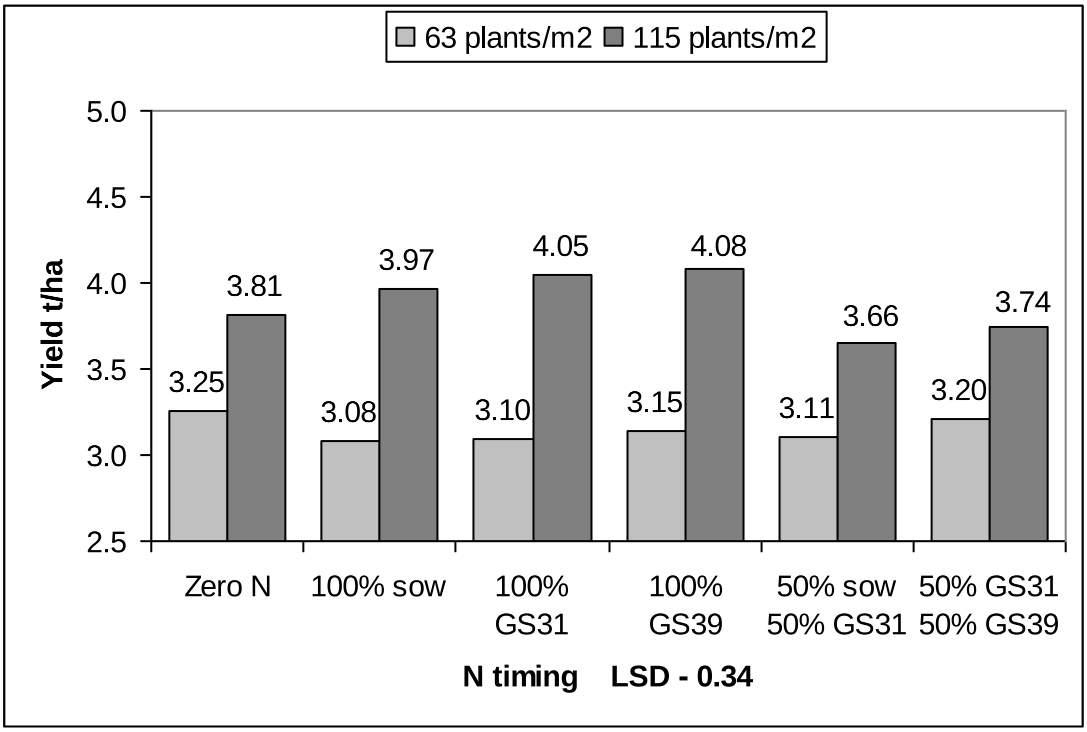

Figure 2: Influence of different nitrogen timings and plant population on yield t/ha (mean of two nitrogen rates) – Mackellar wheat sown 19th May.

When all individual treatments were considered plant population as the determinant of canopy size stood out as the dominant factor influencing yield (figure 4). 115 plants/m^2 was significantly better than 63 plants/m^2 and there was a trend indicating that 100 kg/ha N was more detrimental to yield than 50kg/ha N at the lower plant population but not at the higher plant population with the single applications. Note that there was again a significant interaction (p=5%) between plant population, nitrogen rate and whether nitrogen was split or applied as a single dose.

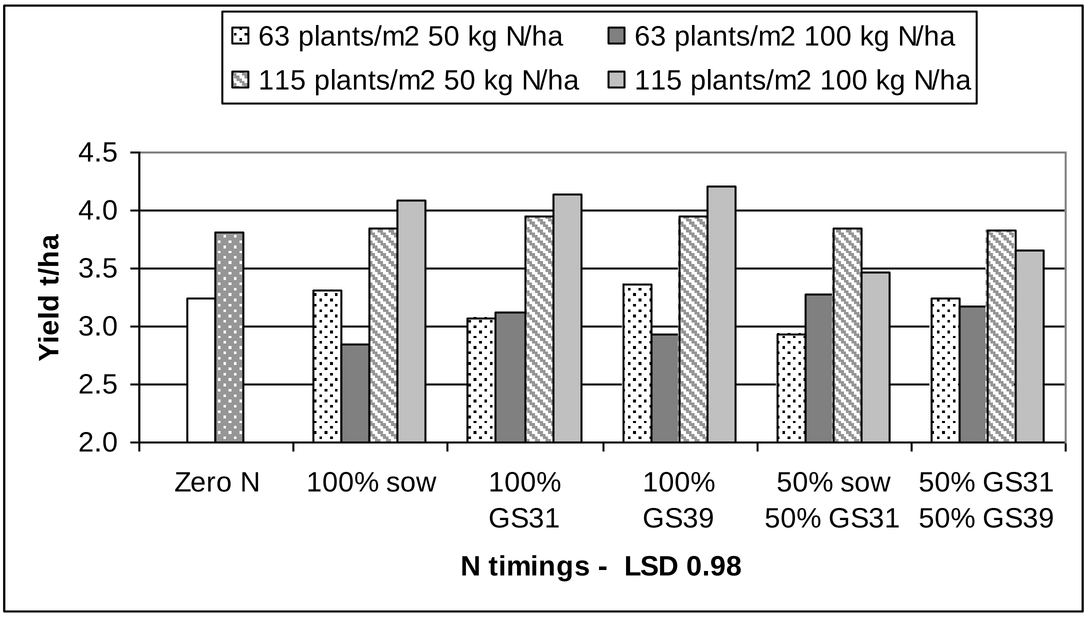

Figure 3: Influence of different nitrogen timings, nitrogen rates and plant population on yield t/ha - Mackellar wheat sown 19th May.

iii) Quality

Unlike the later sowing trial on Mitre (reported as Protocol 3), stem elongation commenced in late August, therefore GS30-31 applications were made earlier on 4th September. As a consequence uptake of this dose was superior to that experienced with the later sowing trial since it was followed by 20mm of rainfall on the 6-7th September. However the GS39 application which was not applied until booting (13th October) received no follow up rain for uptake. All of these effects can be seen in the protein content of the grain of the different treatments as (figure 4).

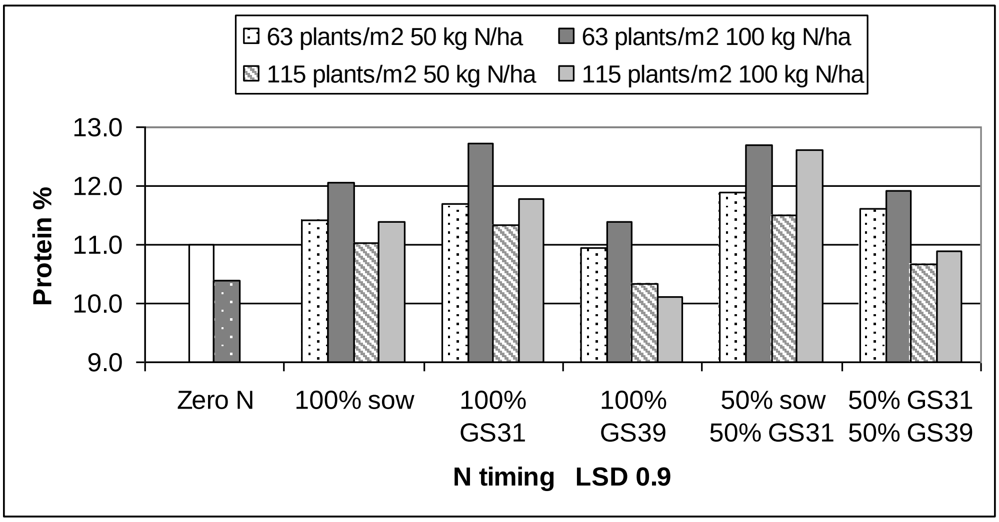

Figure 4: Influence of different nitrogen timings, nitrogen rates and plant population on % Protein – Mackellar 19th May sown.

GS31 and seedbed nitrogen application produced significantly higher protein contents than the control, with the former producing the highest levels. Note however that the GS39 applications were no different to the zero N controls.

As was found with Mitre (other than the nitrogen effect on protein) it was plant population that most influenced quality parameters, screenings, thousand seed weight and test weight were all increased as plant population moved from 63 plants/m^2 to 115 plants/m^2

Conclusions

Feed wheat margins sown in mid-May were double those achieved with early July sown Mitre (Protocol 3), however as was the case with the later sown wheat, nitrogen application did not increase yield, though it did improve protein. Since protein effects did not influence margin return, the highest margins were produced by zero nitrogen plots at the higher plant population.

Table 3. Influence of different nitrogen timings, nitrogen rates and plant population on Yield t/ha, % Protein, Thousand seed weight (g), % Screenings 2.2mm, Test weight kg/hl and margin $/ha (after deduction of nitrogen and seed costs)

Plant pop	N rate	N timing	Yield t/ha	Protein %	TSW g	Screenings %	Test wt kg/ha	Margin $/ha
100	50	Zero N (Control)	3.19	11.1	29.0	15.5	78.1	644
		Seedbed	3.31	11.4	29.6	16.0	78.6	606

		GS30-31	3.07	11.7	29.5	15.0	78.1	557
		GS37-39	3.36	11.0	31.2	15.5	78.9	599
		Seedbed + GS30-31	2.94	11.9	29.6	14.3	78.5	523
		GS30-31 + GS37-39	3.24	11.6	30.8	15.0	78.5	568
	100	Zero N (Control)	3.32	10.8	29.7	15.4	79.0	671
		Seedbed	2.85	12.1	28.9	17.4	77.8	457
		GS30-31	3.12	12.7	27.6	14.4	77.9	512
		GS37-39	2.94	11.4	29.9	15.0	78.7	460
		Seedbed + GS30-31	3.27	12.7	29.5	14.4	77.3	535
		GS30-31 + GS37-39	3.17	11.9	30.1	14.8	77.9	499
200	50	Zero N (Control)	3.78	10.6	31.8	14.0	80.3	755
		Seedbed	3.84	11.0	32.5	12.8	80.1	705
		GS30-31	3.95	11.3	31.0	13.5	79.5	727
		GS37-39	3.95	10.3	32.4	13.7	80.9	707
		Seedbed + GS30-31	3.84	11.5	32.1	12.5	79.8	697
		GS30-31 + GS37-39	3.82	10.7	31.3	14.7	79.8	674
	100	Zero N (Control)	3.84	10.1	31.8	13.8	80.3	767
		Seedbed	4.09	11.4	30.2	13.5	78.7	701
		GS30-31	4.14	11.8	32.4	12.0	79.5	711
		GS37-39	4.21	10.1	31.2	13.9	80.3	704
		Seedbed + GS30-31	3.47	12.6	29.9	12.7	78.1	566
		GS30-31 + GS37-39	3.66	10.9	31.7	13.7	80.3	587
LSD								
[Within Seed rates, Control v Trt]			0.42	0.6	2.1	2.0	1.2	
[Within Seed rates, Trt v Trt]			0.49	0.7	2.4	2.4	1.4	
[Other Comparisons, Control v Trt C v T]			0.98	1.1	2.0	2.0	1.8	
[Other Comparisons, Trt v Trt]			0.98	1.1	2.4	2.4	1.9	
Significant Interaction Contrasts			S rate x N split 5% sig.	S rate x N lateness 5% sig.	nil	Srate x Nlateness 5% sig.	nil	
			Srate x Nrate x Nsplit 5% sig.					

Grain price feed $205/tonne (no adjustment for quality). Cost of nitrogen as urea - $1.10/kg N. Seed including Raxil $250/tonne.
Note: Application costs have been included in the above calculations based on,
Top dressing - $7.5/ha
Wheeling damage has been included for any nitrogen treatment applied at GS39 with yields reduced by 2.5%.