3. CANOPY MANAGEMENT TRIALS

3.1 WHEAT CANOPY MANIPULATION TRIAL - GNARWARRE AND HAMILTON

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Funding Research:
Grains Research and Development Corporation

Location: Gnarwarre and Hamilton

Aim:
To determine the effect of sowing rate and nitrogen fertiliser timing on crop canopy development, grain yield and grain quality.

Method:
A wheat trial was established at Gnarwarre (Geelong) and Hamilton where 2 varieties, namely Kellalac (Spring Wheat) and MacKellar (Winter Wheat) were grown. Each trial was fully replicated (4 reps) and randomized for statistical analysis.

Background:
There is some evidence, particularly under raised bed conditions where waterlogging has been eliminated, that plants can tend to become too vigorous in the early growth stages, producing too much vegetation (leaf and tillers) at the expense of grain fill during spring. Consequently harvest index (ratio of grain to total plant dry matter) can be quite low. Potential grain yield is often not achieved because moisture is limiting during grain fill.

Research coming out of New Zealand is suggesting that by restricting the amount of nitrogen at planting, tiller production can be reduced, thereby reducing the development of the crop canopy in the early stages. It is suggested that by applying nitrogen later in the crop cycle, grain yield and grain quality can be enhanced. It is also suggested that lower seeding rates may assist in better crop canopy development and better grain yield and quality.

GNARWARRE
Sowing Date: 11th June 2003

Table 1: Treatment List

There were 18 treatments ie 3 sowing rates (P1,P2,P3) and 6 fertiliser (F1,F2,F3,F4,F5,F6) treatments.

	F1	F2	F3	F4	F5	F6
P1	1	2	3	4	5	6
P2	7	8	9	10	11	12
P3	13	14	15	16	17	18

Key
P1 = Target pop 85 plants/sq metre
P2 = Target pop 160 plants/sq metre
P3 = Target pop 235 plants/sq metre

F1 = control (no N)
F2 = 75 kg/ha N at sowing + 25 kg/ha N at GS31
F3 = 100 kg/ha N at GS31
F4 = 100 kg/ha N at GS39
F5 = 100 kg/ha N at GS59
F6 = 50 kg/ha N at GS31 + 50 kg/ha N at GS39

Table 2: The Actual Plant Populations Established (Kellalac)

Kellalac				
Population	**Seed Size g/1000 seeds**	**Sowing rate kg/ha**	**Target Population plants/m^2**	**Established Population plants/m^2**
P1	28.9	31	85	86
P2	28.9	58	160	145
P3	28.9	85	235	227

Table 3: The Actual Plant Populations Established (MacKellar)

MacKellar				
Population	**Seed Size g/1000 seeds**	**Sowing rate kg/ha**	**Target Population plants/m^2**	**Established Population plants/m^2**
P1	38.2	41	85	104
P2	38.2	76	160	184
P3	38.2	112	235	240

Table 4: Fertiliser Application Timings

Variety	**GS 31**	**GS 39**	**GS 59**
Kellalac	26/09/03	28/10/03	11/11/03
MacKellar	10/10/03	03/11/03	11/11/03

Fungicides:
All plots were sprayed on 27/10/03 with 1 application of Folicur ® at 290 ml/ha to control leaf rust.

All plots other than the F2 treatments were sown with 150 kg/ha Superphos (0N:15.7P:0K:5.8S), thereby applying 23.55 kg/ha Phosphorus and 8.7 kg/ha Sulphur.

Table 5: Soil Tests Breakdown

Depth (cm)	**Nitrate Nitrogen (ppm)**	**Ammonium Nitrogen (ppm)**	**Total Available Nitrogen (ppm)**	**Phosphorus (Colwell)**
0 – 10	19.5			42.0
10 – 20	8.7	1.0	56.5	
20 – 60	3.0	0.9	56.5	

Summary:

1. Effect of Plant Population and Nitrogen Management on Canopy Structure

The results generated with both varieties indicated that there are many different crop structures that lead to the same yield output. Thus the largest canopies and ear counts were invariably generated by the earliest nitrogen treatments and highest plant populations, however at 100 kg/ha N applied there was no difference in yield between these crops and those that generated 100-150 less ears/m2 and a substantially thinner canopy. One of the principal reasons for this is that whilst the thinner canopies created by later nitrogen has fewer ears/m2, the activity of the canopy is extended during grain fill, compared to thicker earlier fed canopies which senesce earlier.

Whilst yield maybe similar from totally different canopy structures the results indicated that quality attributes maybe totally different, for example, a nitrogen approach based on the seedbed tended to produce lower protein and grain test weights than later applications i.e. growth stages GS31 (1st node) and GS39 (flag leaf emergence).

Overall the results indicated that there is no one single route to optimum yield and quality, thus plant populations in the range of 100-180 plants/m2 produced optimal yields, with an indication that plant populations in excess of 200 plants/m2 held no economic advantage. Nitrogen applications applied between GS31-39 produced crop canopies that had fewer ears/m^2 than nitrogen regimes based on the seedbed. This however produced the best combination of yield and quality with the winter wheat variety MacKellar.

The slower development of MacKellar compared to Kellalac was associated with a higher tiller count in spring. However this did not translate to higher ear numbers, since with Kellalac 75% of tillers produced an ear, compared to 65% with MacKellar (in Hamilton the opposite occurred).

2. Influence of Plant Population on Yield and Grain Quality

Kellalac
Established plant populations of 86,145 and 227 plants/m2 produced yield differences of only 0.3 t/ha when averaged over the 6 nitrogen treatments, with evidence that 145 plants/m2 was the optimal plant population for yield of those tested. There was no yield advantage to the highest plant population, though there was a trend for higher plant populations to give higher grain test weights, a fact also noted with MacKellar. Plant population with Kellalac had a neutral effect on the low level of screenings (1.7%) but there was a significant trend for the lowest plant numbers to give highest protein level.

MacKellar
From the June sowing in this trial there was no yield advantage to plant populations exceeding 104 plants/m2 (others populations tested were 184 and 227 plants/m2). Again a difference in plant population from 104 to 240 plants/m2 created yield differences of 0.3 t/ha, in this case the highest population producing the lowest yield. Many of the trends exhibited by Kellalac in terms of influence on quality were seen with MacKellar, that is, the highest plant population gave the highest grain test weights, lowest screenings and lowest protein. However these differences whilst significant were also small.

Overall for mid June sowings the results indicated that plant populations of 100-150 plants/m2 gave optimum results in terms of yield and quality. Earlier sowings are likely to have the effect of increasing the period of tillering and thus the ability to compensate from lower plant populations.

3. Influence of Nitrogen Management on Yield and Grain Quality

There was a strong response to nitrogen application with both varieties, with 100 kg/ha N creating a maximum yield increase of 1.26 t/ha with Kellalac and 0.87 t/ha with MacKellar, when averaging seed rates. The optimum single dose timing for nitrogen with both varieties was from application made at GS31 (1st node) – (see Figure 1), however similar yield and quality was achieved with a 50/50 split applied at GS31 and GS39 (flag leaf emergence). Whilst single applications of nitrogen applied at GS39 gave superior grain test weights and protein compared to GS31, yield was reduced by 0.28-0.29 t/ha (not significant) with both varieties.

Application of nitrogen later than GS39 i.e. GS59 (ear emergence) gave significantly lower yields and from quality measurements indicated that nitrogen was not fully utilised, since protein levels were similar to the unfertilised control - (see Figure 2). Whilst placing a strong emphasis on nitrogen in the seed bed i.e. 75% of the N applied (separated from the seed) gave higher ear counts than GS31 applications, this approach had slightly lower yields and proteins.

There was no significant difference in yield or quality depending on whether nitrogen dose was applied as a single or split dose.

4. Interactions Between Plant Population and Nitrogen Management

With MacKellar there was a significant interaction between plant population and nitrogen management, which suggested that the later nitrogen was applied, the greater the advantage to lower seeding rates.

It was also apparent that in the absence of applied nitrogen it was an advantage to opt for lower seed rates.

Results:

Table 6: Influence of Plant Population on Yield and Quality of Kellalac (Mean of 6 Nitrogen Treatments) - Gnarwarre

Population	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
P1	5.61	77.3	1.7	11.3
P2	5.91	77.7	1.7	10.6
P3	5.82	78.0	1.7	10.7
LSD	**0.27**	**0.3**	**0.6**	**0.3**
Significance of linear trend	*ns*	**	*ns*	**

Table 7: Influence of Nitrogen Management on Yield and Quality of Kellalac (mean of 3 plant populations – Gnarwarre

Fertiliser	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
F1	4.98	77.1	2.1	8.4
F2	5.98	77.4	1.7	11.2
F3	6.22	77.0	1.6	11.9
F4	5.94	78.5	1.4	12.2
F5	5.33	78.2	1.9	9.9
F6	6.24	77.7	1.6	11.8
LSD(5%)	**0.35**	**0.5**	**0.3**	**0.5**
Significance of:				
Control vs Nitrogen (CvN)	***	**	***	***
Lateness of N	***	***	*ns*	***
Split vs Unsplit	*ns*	*ns*	*ns*	*ns*

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 8: Influence of Nitrogen Management and Plant Population on Yield, Crop Structure and Quality of Kellalac - Gnarwarre

Fertiliser	Popul-ation	Yield t/ha	Test Weight kg/hl	Screen %	Protein %	Plant Count	Tiller Count	Tillers / Plant	Ear Count	Ears / Tiller (%)
F1	P1	4.84	77.4	2.2	8.6	86.9	525.8	6.1	378.5	72.0
	P2	5.29	76.9	1.8	8.3	144.8	547.8	3.8	400.5	73.1
	P3	4.83	77.0	2.4	8.2	227.9	607.0	2.7	420.5	69.3
F2	P1	5.77	76.7	1.8	11.6	86.9	600.0	6.9	450.3	75.1
	P2	6.20	77.7	1.8	10.6	144.8	715.0	4.9	544.8	76.2
	P3	5.97	77.7	1.5	11.5	227.9	755.8	3.3	543.3	71.9
F3	P1	5.85	76.0	1.7	12.5	86.9	487.5	5.6	399.5	81.9
	P2	6.15	77.3	1.8	11.5	144.8	525.0	3.6	428.3	81.6
	P3	6.64	77.6	1.3	11.6	227.9	606.3	2.7	474.5	78.3
F4	P1	5.77	78.1	1.2	12.4	86.9	501.5	5.8	355.0	70.8
	P2	6.18	78.7	1.4	12.0	144.8	560.5	3.9	401.5	71.6
	P3	5.85	78.7	1.7	12.1	227.9	569.0	2.5	380.0	66.8
F5	P1	5.45	78.0	1.9	10.5	86.9	483.5	5.6	357.3	73.9
	P2	5.45	78.0	1.9	10.0	144.8	560.0	3.9	413.8	73.9
	P3	5.10	78.7	2.0	9.3	227.9	632.3	2.8	435.8	68.9
F6	P1	5.99	77.2	1.6	12.1	86.9	521.3	6.0	435.8	83.6
	P2	6.21	77.8	1.7	11.5	144.8	566.0	3.9	470.8	83.2
	P3	6.53	78.0	1.4	11.8	227.9	604.3	2.7	453.3	75.0
LSD(5%)							**58.4**		**49.2**	
Within Seed rates		*0.61*	*0.9*	*0.5*	*0.9*					
Other Comparisons		*0.59*	*0.9*	*0.7*	*0.9*					
CV%		**7.3%**								

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 9: Influence of Plant Population on Yield and Quality of MacKellar (Mean of 6 Nitrogen Treatments) - Gnarwarre

Population	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
P1	6.02	75.4	8.0	9.9
P2	6.02	76.1	7.1	9.6
P3	5.72	76.2	6.9	9.6
LSD	0.26	0.6	0.8	0.4
Significance of linear trend	*	*	**	*ns*

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 10: Influence of Nitrogen Management on Yield and Quality of MacKellar (Mean of 3 Plant Populations) – Gnarwarre

Fertiliser	Mean Yield t/Ha	GrainTest Weight kg/hl	Screen %	Protein %
F1	5.42	75.1	7.3	7.7
F2	6.09	75.0	8.6	10.7
F3	6.26	75.2	8.1	10.2
F4	5.97	77.3	6.1	10.7
F5	5.52	76.7	6.8	8.6
F6	6.29	76.1	7.0	10.4
LSD(5%)	**0.34**	**0.7**	**1.2**	**0.3**
Significance of:				
Control vs Nitrogen (CvN)	***	***	*ns*	***
Lateness of N	***	***	***	***
Split vs Unsplit	*ns*	*ns*	*ns*	*ns*

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 11: Influence of Nitrogen Management and Plant Population on Yield, Crop Structure and Quality of MacKellar - Gnarwarre

Fertiliser	Popul-ation	Yield t/ha	Test Weight kg/hl	Screen %	Protein %	Plant Count	Tiller Count	Tillers / Plant	Ear Count	Ears / Tiller (%)
F1	P1	5.74	75.0	8.6	8.2	104	626	6.02	372	59.4
	P2	5.36	75.1	6.6	7.5	184	582	3.26	400	68.7
	P3	5.17	75.2	6.8	7.5	240	789	3.28	462	58.6
F2	P1	6.13	74.2	9.3	11.0	104	630	6.06	476	75.5
	P2	6.26	75.4	8.1	10.3	184	714	3.88	573	80.2
	P3	5.87	75.6	8.5	10.6	240	968	4.03	586	60.5
F3	P1	6.14	74.1	9.0	10.8	104	692	6.65	435	62.9
	P2	6.73	76.0	7.8	10.0	184	687	3.73	451	65.6
	P3	5.91	75.6	7.5	9.8	240	701	2.92	431	61.5
F4	P1	6.12	76.9	6.6	10.4	104	538	5.17	383	71.2
	P2	6.11	78.0	5.6	10.9	184	593	3.22	384	64.8
	P3	5.68	77.1	6.1	10.8	240	632	2.63	401	63.4
F5	P1	5.67	76.1	7.7	8.5	104	565	5.43	311	55.0
	P2	5.64	76.5	6.7	8.6	184	579	3.15	410	70.8
	P3	5.24	77.4	6.0	8.6	240	623	2.59	405	65.0
F6	P1	6.34	75.9	6.9	10.5	104	532	5.11	357	67.1
	P2	6.05	75.9	7.7	10.4	184	657	3.57	385	58.6
	P3	6.47	76.5	6.3	10.2	240	737	3.07	461	62.6
LSD(5%)									**75.1**	
Within Seed rates		*0.69*	*0.59*	*2.0*	*0.5*					
Other Comparisons		*0.68*	*0.58*	*2.0*	*0.6*					
CV%		**6.9%**								

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Figure 1: Influence of Nitrogen Timing on Yield – Gnarwarre 2004

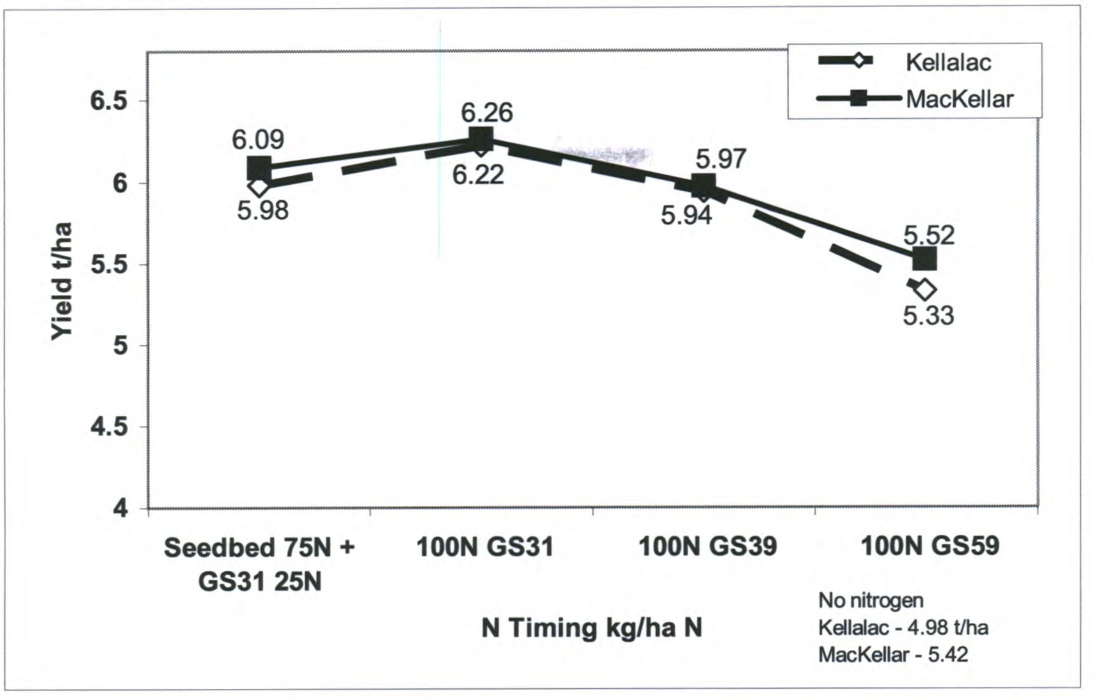
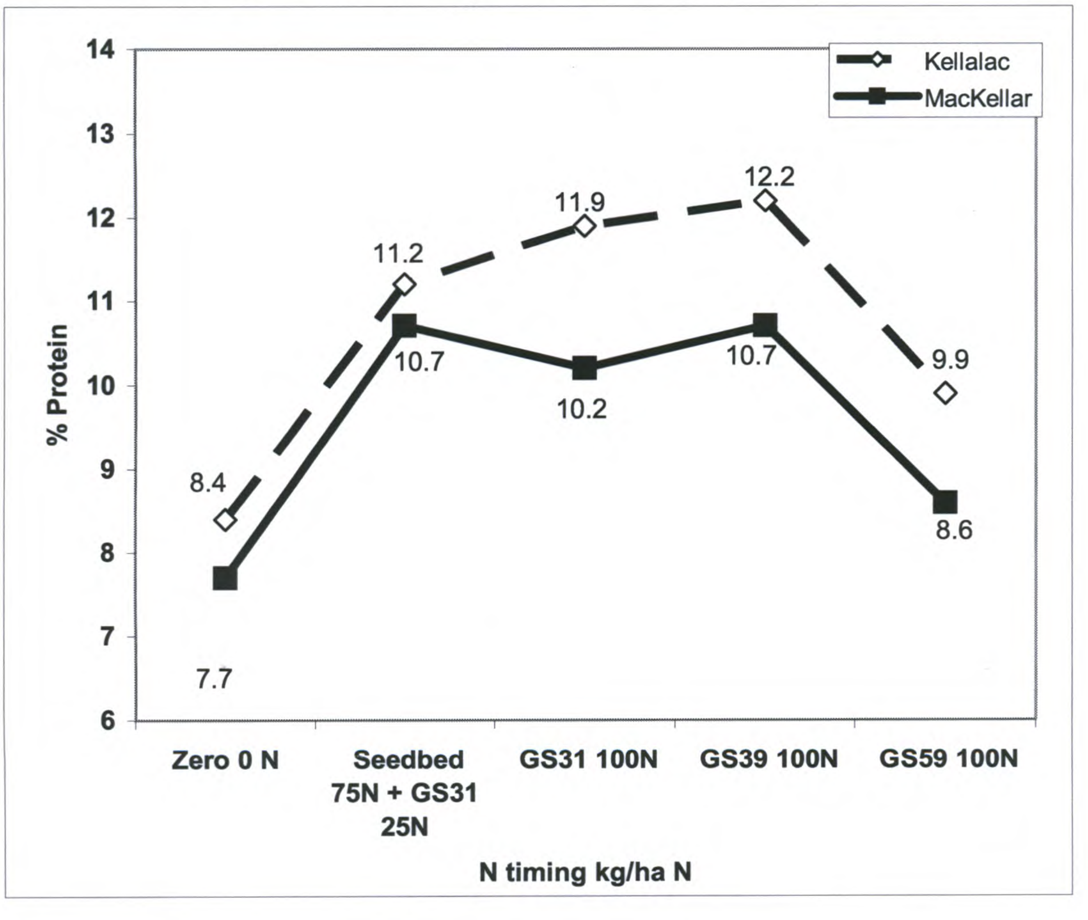


Figure 2: Influence of Nitrogen Timing on % Protein – Gnarwarre 2004



HAMILTON CANOPY TRIAL

Sowing Date: 27th May 2003

Table 12: Treatment List

There were 18 treatments ie 3 sowing rates (P1,P2,P3) and 6 fertiliser (F1,F2,F3,F4,F5,F6) treatments.

	F1	F2	F3	F4	F5	F6
P1	1	2	3	4	5	6
P2	7	8	9	10	11	12
P3	13	14	15	16	17	18

Key

P1 = Target pop 85 plants/sq metre
P2 = Target pop 160 plants/sq metre
P3 = Target pop 235 plants/sq metre

F1 = control (no N)
F2 = 75 kg/ha N at sowing + 25 kg/ha N at GS31
F3 = 100 kg/ha N at GS31
F4 = 100 kg/ha N at GS39
F5 = 100 kg/ha N at GS51
F6 = 50 kg/ha N at GS31 + 50 kg/ha N at GS39

Table 13: The Actual Plant Populations Established (Kellalac)

Kellalac				
Population	**Seed Size g/1000 seeds**	**Sowing rate kg/ha**	**Target Population plants/m^2**	**Established Population plants/m^2**
P1	28.9	31	85	86
P2	28.9	58	160	145
P3	28.9	85	235	227

Table 14: The Actual Plant Populations Established (MacKellar)

MacKellar				
Population	**Seed Size g/1000 seeds**	**Sowing rate kg/ha**	**Target Population plants/m^2**	**Established Population plants/m^2**
P1	38.2	41	85	95
P2	38.2	76	160	156
P3	38.2	112	235	261

Table 15: Fertiliser Application Timings

Variety	**GS 31**	**GS 39**	**GS 51**
Kellalac	26/08/03	24/10/03	10/11/03
MacKellar	04/09/03	27/10/03	10/11/03

All plots other than the F2 treatments were sown with 150 kg/ha Superphos (0N:15.7P:0K:5.8S), thereby applying 23.55 kg/ha Phosphorus and 8.7 kg/ha Sulphur

Soil Test Results:

Table 16: Soil Test Breakdown

Depth (cm)	**Nitrate Nitrogen (ppm)**	**Ammonium Nitrogen (ppm)**	**Total Available Nitrogen (ppm)**	**PH (water)**
0 – 60	15.0	0.9	126.0	6.4

Summary:

1. Effect of Plant Population and Nitrogen Management on Canopy Structure.

Overall there was a tendency for higher seed rates and thicker crop canopies to produce higher yields at the Hamilton site, however the degree of compensation from lower plant populations was more successful with MacKellar than with Kellalac.

Results indicated that moving nitrogen forward to the seedbed increased tiller numbers recorded at GS31, however this tiller number advantage did not translate into more fertile ear numbers when compared to single nitrogen doses applied at GS31. Thus comparing nitrogen timing where emphasis is placed in the seedbed versus GS31, the extra tillers were not translated into extra yield (Figure 3.)

As was noted at Gnarwarre, crop canopies created by nitrogen applied at GS39 (flag leaf emergence were much smaller and open than the seedbed and GS31 timings, however though lower yielding it was noted that these canopies remained greener for longer compared to earlier N timing.

Unlike last season and somewhat unusually, MacKellar produced lower tiller numbers per plant than Kellalac, yet MacKellar produced the best compensation from lower seed rates. In the spring MacKellar was noted to move into the stem elongation phase slightly later than Kellalac, a development characteristic that may give later forming tillers more opportunity to create a viable ear. Overall Kellalac showed only 45% conversion of tillers at GS31 into viable ears/m2 at harvest (average of all treatments), in comparison to 60% with MacKellar.

Since there was no lodging at this site there was no penalty for the thicker canopies produced by high nitrogen dressings to the seedbed, but this would have to be considered with weaker strawed varieties where applications at GS31 would be less prone to lodging.

2. Influence of Plant Population on Yield and Grain Quality

Established plant populations of 88,125 and 173 plants/m2 with Kellalac produced yield differences of 0.54 t/ha (averaged over the 6 nitrogen treatments), with a significant linear trend suggesting that higher plant populations produced higher yields. There was a similar but non-significant trend with MacKellar, the difference in yield between the populations (95, 156 & 261 plants/m2) being only 0.26t/ha.

This difference maybe due to the longer tillering period with MacKellar compared to Kellalac, which allowed a greater degree of compensation.

There was no significant influence of plant population on grain quality at this site with either variety.

3. Influence of Nitrogen Management on Yield and Grain Quality

The response to nitrogen application at Hamilton was not as great as at Gnarwarre, since the site was inherently more fertile (126kg/ha N available N 0-60 cm) at the start of the season. 100 kg/ha N created a maximum yield increase of 0.57 t/ha with Kellalac and 0.69 t/ha with MacKellar, when averaging seed rates. The optimum timing for nitrogen with both varieties was from a split application (75% N in the seedbed and 25% at GS31-1st node), however there was no statistical difference between this split and a single timing at GS31– (Figure 4)

The later nitrogen was applied, the lower was the yield, however since fertility was relatively high, the slope of this decline was relatively shallow. As was seen in Gnarwarre, the single nitrogen application at ear emergence GS51 did not create a yield increase with either variety, although some uptake did occur since protein levels were increased.

Again as was experienced with the Gnarwarre trial, later nitrogen timings produced higher protein levels, with nitrogen doses at GS39 giving the highest protein levels (Figure 5). After this growth stage (despite lower yields - which might usually be expected to increase protein) the content dropped. There was no advantage to splitting the 100 kg/ha N dose 50/50 between GS31 and GS39, since whilst yields were the same as GS31 main dose timings, the protein levels were also the same, showing no tendency to follow the protein levels recorded from single GS39 timings. There were no significant effects of nitrogen timing on specific weight. Other effects on quality such as screenings were very small in this trial.

4. Interactions Between Plant Population and Nitrogen Management

With Kellalac there was a significant interaction between plant population and nitrogen management, which suggested that with no nitrogen applied the trend for higher seed rates to produce the highest yields was much reduced.

This was also apparent where nitrogen was applied too late again indicating that with restricted nitrogen supply lower seed rates were less disadvantaged compared to fertilised plots.

There were no significant yield interactions between plant population and nitrogen management in MacKellar.

Results:

Table 17: Influence of Plant Population on Yield and Quality of Kellalac (mean of 6 nitrogen treatments) - Hamilton

Population	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
P1	4.66	74.2	1.8	11.2
P2	4.98	74.7	1.6	11.1
P3	5.19	74.8	1.6	11.0
LSD (5%)	**0.38**	**0.7**	**0.3**	**0.4**
Significance of linear trend	*	*ns*	*ns*	*ns*

Table 18: Influence of Nitrogen Management on Yield and Quality of Kellalac (mean of 3 plant populations – Hamilton

Main Effect of Nitrogen	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
F1	4.68	74.3	1.7	10.2
F2	5.25	75.2	1.5	11.3
F3	5.12	74.4	1.4	11.3
F4	4.85	74	1.8	12
F5	4.66	74.6	1.8	10.7
F6	5.08	74.8	1.8	11
LSD (5%)	**0.21**	**0.9**	**0.4**	**0.3**
Significance of:				
Control vs Nitrogen (CvN)	***	*ns*	*ns*	***
Lateness of N	***	*ns*	*	*
Split vs Unsplit	*ns*	*ns*	*ns*	***

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 19: Influence of Nitrogen Management and Plant Population on Yield, Crop Structure and Quality of Kellalac - Hamilton

Fertiliser	Popul-ation	Yield t/ha	Test Weight kg/hl	Screen %	Protein %	Plant Count	Tiller Count	Tillers / Plant	Ear Count	Ears / Tiller (%)
F1	P1	4.51	75.9	1.5	10.3	88.6	660	7.45	309	46.8
	P2	4.63	73.2	1.8	10.3	125.1	838	6.70	363	43.3
	P3	4.91	73.8	1.8	10.1	173	1019	5.89	413	40.5
F2	P1	4.85	73.6	2.0	11.6	88.6	710	8.01	361	50.8
	P2	5.26	76.1	1.0	11.3	125.1	1003	8.02	444	44.3
	P3	5.64	75.7	1.4	11.0	173	1149	6.64	492	42.8
F3	P1	4.83	73.4	1.6	11.5	88.6	682	7.69	369	54.1
	P2	5.11	75.3	1.3	11.5	125.1	865	6.91	441	51.0
	P3	5.40	74.5	1.5	11.0	173	957	5.53	424	44.3
F4	P1	4.55	73.0	2.1	12.0	173	957	5.53	424	44.3
	P2	4.98	73.5	2.0	11.9	125.1	840	6.71	367	43.7
	P3	5.02	75.5	1.1	12.1	173	991	5.73	394	39.8
F5	P1	4.43	74.7	1.9	11.0	88.6	674	7.61	311	46.1
	P2	4.77	74.9	2.1	10.5	125.1	857	6.85	372	43.4
	P3	4.79	74.2	1.5	10.6	173	945	5.46	393	41.6
F6	P1	4.77	74.4	1.9	11.0	88.6	802	9.05	395	49.3
	P2	5.13	75.2	1.4	11.2	125.1	855	6.83	388	45.4
	P3	5.36	74.8	2.0	11.0	173	1090	6.30	478	43.8
LSD(5%)								**159**	**66**	
Within Seed rates		*0.44*	*0.38*	*0.7*	*0.6*					
Other Comparisons		*0.55*	*0.47*	*0.7*	*0.7*					
CV%		**5.3%**								

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 20: Influence of Plant Population on Yield and Quality of MacKellar (mean of 6 nitrogen treatments) – Hamilton

Population	Mean Yield t/Ha	Grain Test Weight kg/hl	Screen %	Protein %
P1	5.86	73.32	3.8	10.7
P2	6.00	73.43	3.9	10.3
P3	6.12	73.72	3.8	10.3
LSD (5%)	**0.33**	**0.54**	**0.8**	**0.4**
Significance of linear trend	*		*ns*	*ns*

Table 21: Influence of Nitrogen Management on Yield and Quality of MacKellar (mean of 3 plant populations – Hamilton

Fertiliser	Mean Yield t/Ha	Test Weight kg/hl	Screen %	Protein %
F1	5.69	73.72	3.6	9.5
F2	6.38	73.38	4.1	10.8
F3	6.22	73.02	4.5	10.6
F4	5.80	73.07	3.9	11
F5	5.77	74.23	3.1	10
F6	6.12	73.50	3.9	10.5
LSD (5%)	**0.18**	**0.76**	**0.7**	**0.3**
Significance of:				
Control vs Nitrogen (CvN)	***		*ns*	***
Lateness of N	***		**	***
Split vs Unsplit	*ns*		*ns*	*

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Table 22: Influence of Nitrogen Management and Plant Population on Yield, Crop Structure and Quality of MacKellar - Hamilton

Fertiliser	Popul-ation	Yield t/ha	Test Weight kg/hl	Screen %	Protein %	Plant Count	Tiller Count	Tillers / Plant	Ear Count	Ears / Tiller (%)
F1	P1	5.65	73.60	4.1	9.8	95.2	545	5.72	339	62.2
	P2	5.59	73.60	3.5	9.5	156.2	653	4.18	369	56.5
	P3	5.84	73.95	3.2	9.4	261.7	744	2.84	362	48.7
F2	P1	6.15	73.85	3.7	11.1	95.2	593	6.23	382	64.4
	P2	6.47	72.65	4.3	10.4	156.2	655	4.19	436	66.6
	P3	6.51	73.65	4.3	10.9	261.7	903	3.45	473	52.4
F3	P1	5.98	72.85	4.2	10.9	95.2	475	4.99	354	74.5
	P2	6.36	72.80	4.9	10.5	156.2	621	3.98	405	65.2
	P3	6.33	73.40	4.3	10.4	261.7	838	3.20	474	56.6
F4	P1	5.72	72.70	3.9	11.4	95.2	540	5.67	330	61.1
	P2	5.66	73.20	4.0	11.1	156.2	595	3.81	337	56.6
	P3	6.01	73.30	3.9	10.5	261.7	838	3.20	415	49.5
F5	P1	5.56	73.75	3.1	10.3	95.2	494	5.19	330	66.8
	P2	5.83	74.50	3.2	9.8	156.2	635	4.07	351	55.3
	P3	5.90	74.45	3.1	9.7	261.7	805	3.08	411	51.1
F6	P1	6.08	73.15	4.0	10.4	95.2	572	6.01	403	70.5
	P2	6.12	73.80	3.4	10.5	156.2	504	3.23	344	68.3
	P3	6.18	73.55	4.2	10.6	261.7	785	3.00	439	55.9
LSD (5%)										
Within Seed rates		*0.31*		*1.2*	*0.6*					
Other Comparisons		*0.40*	*1.36*	*1.3*	*0.6*					
CV%		**3.6%**								

Note: ns=not significant; *=5% sig; **=1% sig; ***=0.1% sig.

Figure 3: Influence of Nitrogen Timing on Tiller/Ear Ratio – Hamilton

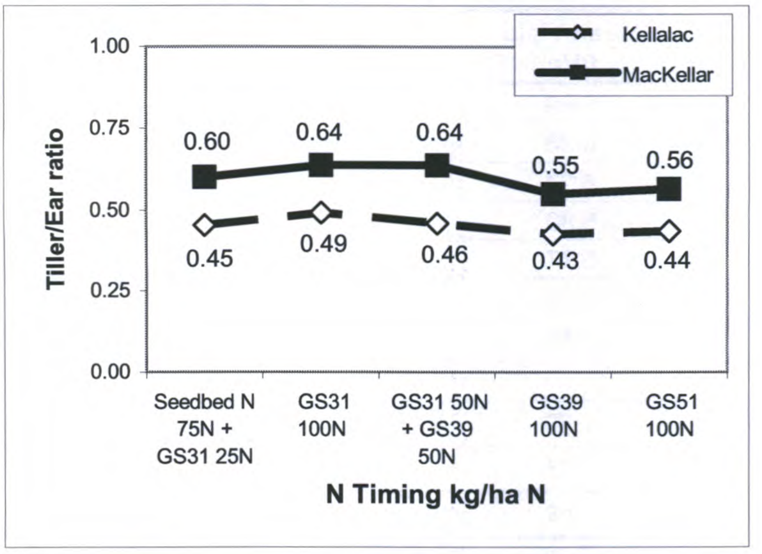


Figure 4: Influence of Nitrogen Timing on Yield – Hamilton

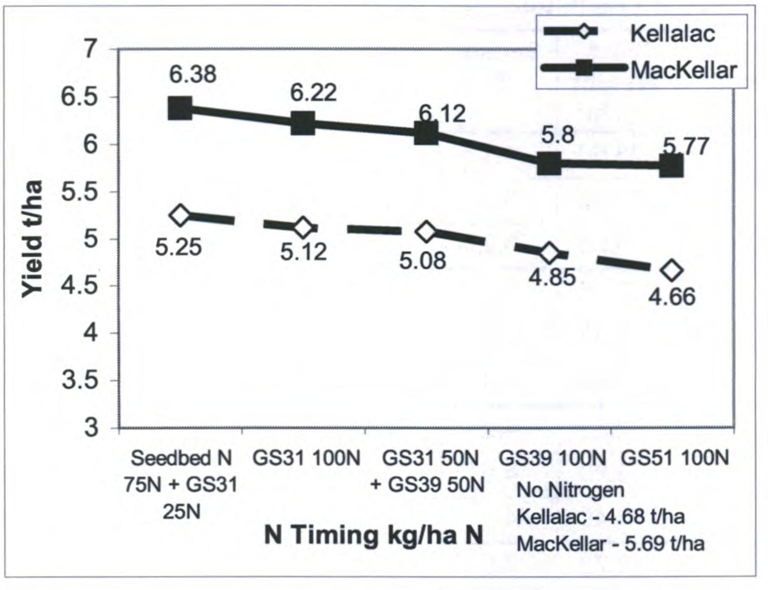


Figure 5: Influence of Nitrogen Timing on % Protein – Hamilton