Interaction of nitrogen strategy with disease management in barley - Rupanyup, Wimmera

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This trial is part of a GRDC funded project (SFS 00015) which started in July 2005. The project looks at canopy management and its integration with disease management principles in the different climates of southern Australia.

Take home messages

- In a decile 1 growing season, with no rainfall in October, barley yielded between 1 -1.5 t/ha. Baudin averaged 1.38 t/ha, with the experimental low protein barley VB0229 averaging 1.31 t/ha. Both were superior to Gairdner, which as a result of poorer establishment, averaged only 1.02 t/ha.
- In a second cereal situation after wheat (soil nitrogen 25kg/ha N in the top 60cm at sowing) 75 kg/ha N applied to the seedbed produced significantly lower yields (0.11t/ha) than the equivalent dose applied at GS30 (mean of 3 varieties). However with no zero N controls in the trial, it is not possible to conclude whether there was a response to nitrogen overall.
- Despite lower dry matter levels at harvest and smaller green surface areas at early ear emergence GS55, yields associated with GS30 nitrogen were equal or superior (depending on variety) to seedbed nitrogen application.
- Nitrogen strategy in the 2006 season did not influence response to fungicide.
- The experimental low protein barley VB0229 (13.2%) produced significantly lower mean protein levels than Baudin (13.7%) and Gairdner (14.8%) in response to the same nitrogen applications.
- Unlike the 2005 results, protein levels were not increased by the later GS30 nitrogen applications, in fact GS30 application resulted in lower grain protein in 2006. In part this result may have been due to slightly higher yields associated with this nitrogen timing, particularly with Gairdner and VB0229. However, it is possible that not all the nitrogen applied at GS30 was taken up by the crop due lack of following rainfall, a fact that would have also registered lower grain protein levels.

Background

Creating smaller less vegetative canopies in wheat can be accomplished with applying nitrogen during stem elongation (GS30 – 39). This approach has clearly been associated with higher protein levels in the grain. In malting barley an increase in grain protein may not necessarily be a desirable effect due to lower protein requirements for malting classifications.

In this trial “upfront” nitrogen was compared to GS30 applied nitrogen in 3 malting barley varieties, examining the influence of these two different nitrogen strategies on yield, quality, the requirement for disease control and overall crop structure. One of the theories is that barley crops treated with earlier nitrogen might be more predisposed to disease. In the 2005 season where some nitrogen was applied at GS30-31, there was less response to fungicide in both

varieties (Baudin & Gairdner), crops were significantly thinner at the end of tillering and grain proteins were higher.

Methods

Plot size: 25m x 3m

Reps: 4

Three varieties of barley Baudin, Gairdner and VB0229 (an experimental low grain protein barley breeder's line) were dry sown on 1st June at a target plant population of 200 plants/m^2 (actual plant populations are reported in Table 2). The three varieties were subject to two variables: fungicide management and nitrogen management (Table 1). In all other respects the crops were treated with the same overall inputs.

Table 1: Fungicide management programs and nitrogen regimes (kg/ha N) – Rupanyup, Wimmera

1. Fungicide management: 4 fungicide programs were applied to each variety

GS30-31 Application	GS45 – 49 (Booting - 1st awns)
----	----
1. Untreated	
2. Tilt/Bumper 250 ml/ha	----
3. ----	Tilt/Bumper 250 ml/ha
4. Tilt/Bumper 250 ml/ha	Tilt/Bumper 250 ml/ha

Tilt or Bumper @ 250 ml/ha contains 62.5 g/ha ai propiconazole.

Each fungicide strategy was superimposed on two nitrogen regimes applying 75kg/ha N applied at the different timings.

2. Nitrogen regime (kg/ha N)

Trt No.	Nitrogen Timing	
	Seedbed (June 1)	GS30 (Aug 10)
1	75 N	----
2.	----	75 N

Herbicide: *Glyphosate Powermax 2l/ha (pre sowing) – 31st May 2006*

Achieve 250g/ha with Supercharge – 28th July 2006

Results

Plant establishment and crop structure assessments.

Table 2: Plant establishment (plants/m^2) in Baudin, Gairdner and VB0229 when assessed on 19th July at GS13.

	Baudin	*Gairdner*	*VB0229*
Untreated	185	126	172

Due to poor germination the establishment of Gairdner was significantly inferior to the other two varieties. It is suspected that this lower plant population influenced both resultant yield and quality relative to the other two varieties.

Table 3: Effect of seedbed N on tillers/m2 at GS39 in Baudin, Gairdner and VB0229 – 11th September

Nitrogen regime	*Baudin*	*VB 0229*	*Gairdner*
75 N seedbed	749	725	595
75 N GS30	536	563	445

As might have been expected seedbed nitrogen in this low soil nitrogen scenario significantly increased tiller number relative to the GS30 application in all three varieties. However other than in Baudin this did not relate to significantly higher ear numbers (Table 4).

Table 4: Effect of nitrogen strategy and fungicide treatment on ears/m2 at the end of grain fill in Baudin, Gairdner and VB0229 – 29th November

Nitrogen regime	*Fungicide trt.*	*Variety*		
		Baudin	VB 0229	Gairdner
75 N - Seedbed	Mean	**548**	**490**	**349**
75 N - GS30	Mean	**480**	**500**	**407**
LSD 0.05 or 5%– Variety/Nitrogen/Fungicide		**155**		

Yields

Influence of variety

Baudin was on average 0.36 t/ha higher yielding than Gairdner barley with the experimental barley VB0229 0.28 t/ha higher yielding than Gairdner. However it should be emphasized that the sub optimal plant population experienced with Gairdner was most likely the cause of the yield differences.

Influence of fungicide

With only low levels of Spot Form of Net Blotch (SFNB) present and an extremely dry season, disease played very little part in this trial. None of the yield differences associated with fungicides were statistically significant.

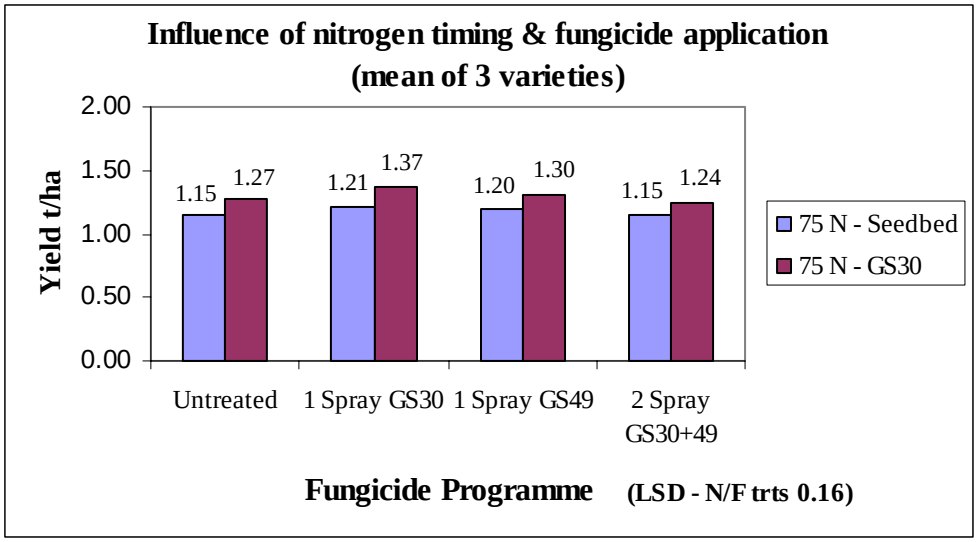

Figure 1: Effect of nitrogen strategy and fungicide treatment on yield (t/ha), when comparing across the means of 3 varieties. LSD (5%) N/F value of 0.16 allows comparison between the individual nitrogen/fungicide treatments.

Influence of nitrogen

Taking a mean of the three varieties there was a significant 0.11t/ha yield advantage to GS 30 applied nitrogen over seedbed nitrogen, though since there was no untreated nitrogen plots it is not possible to state that there was a response to applied nitrogen.

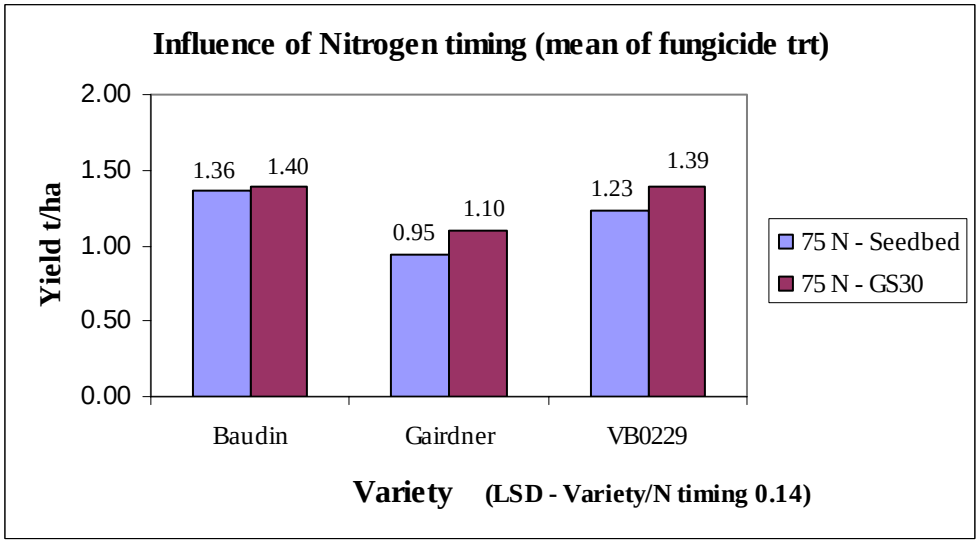

Figure 2: Yield differences (t/ha) associated with nitrogen timing in the individual varieties.

Looking at the individual varieties there was a significant advantage to later nitrogen in Gairdner and the experimental variety VB0229.

Nitrogen timing fungicide interaction in individual varieties

There was no interaction between fungicide application and nitrogen timing for any of the three varieties.

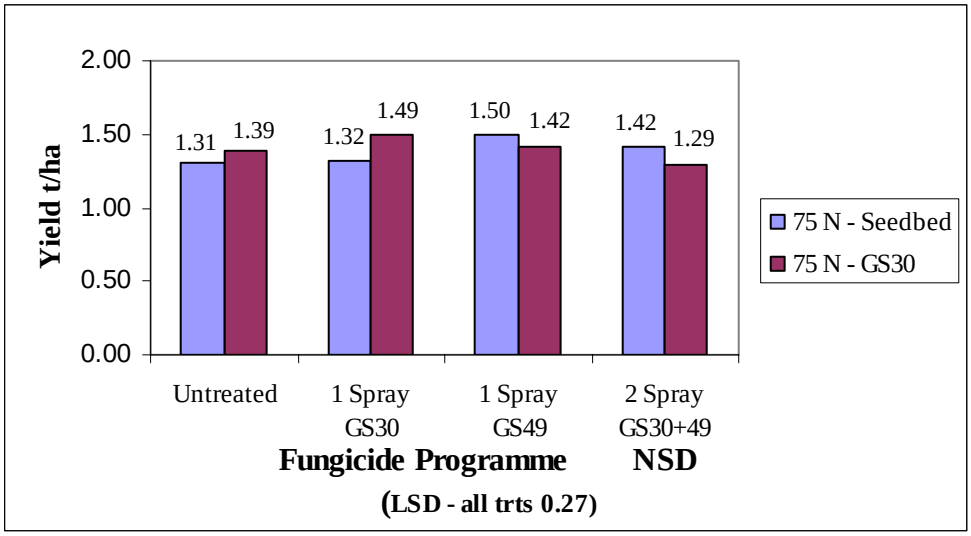

Figure 3. Effect of nitrogen strategy and fungicide treatment on yield t/ha – Baudin

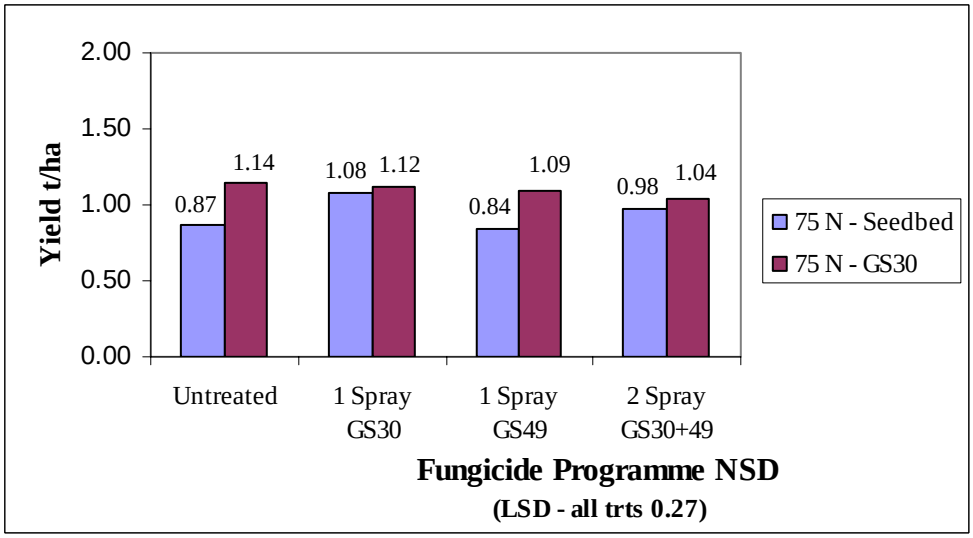

Figure 4. Effect of nitrogen strategy and fungicide treatment on yield t/ha –Gairdner

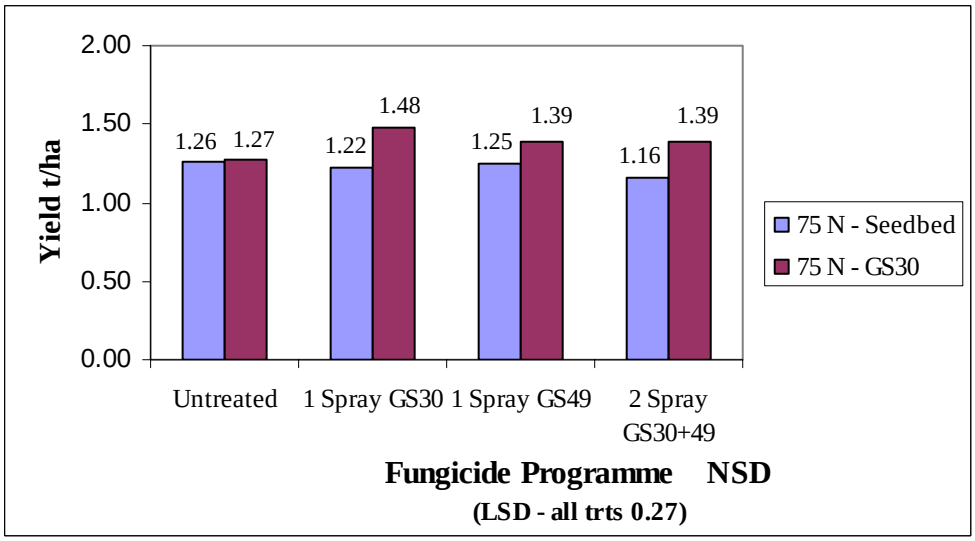

Figure 5. Effect of nitrogen strategy and fungicide treatment on yield t/ha –VB0229

Dry Matter at harvest (t/ha)

Above ground dry matter was recorded at harvest and revealed little difference in dry matter due to treatment, however with Baudin there was significantly more dry matter associated with seedbed nitrogen. This higher harvest dry matter did not however relate to yield. Since the yield was almost identical for the two nitrogen timings in Baudin, it indicated that the harvest index (the percentage of final dry matter that is grain) was lower where seedbed N had been applied (approximately 33%) compared to GS30 application (approximately 43%). The relatively low indexes are likely to have been caused by a combination of drought and frost damage.

Table 5: Effect of nitrogen strategy and variety (mean of fungicide treatments) on above ground dry matter (t/ha) at harvest in Baudin, Gairdner and VB0229 – 29th November.

Nitrogen regime	*Fungicide trt.*	*Variety*		
		Baudin	VB 0229	Gairdner
75 N - Seedbed	Mean	**4.18**	**4.18**	**3.47**
75 N – GS30	Mean	**3.25**	**3.71**	**3.66**
LSD – Variety/Nitrogen timing		**0.80**		

Green Area Index (recorded at early ear emergence GS55)

The amount of green leaf area per meter squared, known as green area index (GAI), was measured at GS55 to compare the influence of nitrogen timing on crop photosynthetic area. At GS55 green area of leaves and stem was calculated for the different nitrogen timings on the 3 varieties tested. Since there were no effects of the fungicide treatments on leaf disease, there were no assessments made of fungicide treatments on GAI. With the exception of Gairdner (where establishment was lower), the GAI of crops treated with seedbed nitrogen was higher than those crops treated with nitrogen at GS30 (Table 6). That is, plots that received nitrogen at sowing had more green area/m^2 than those that did not receive nitrogen until GS30. The higher GAI was due to higher dry matter production resulting from the early nitrogen. Despite the higher GAI in the seedbed nitrogen treatment, final grain yields were no different between the seedbed and GS30 nitrogen treatments. That is, the bigger crop canopy at GS55 did not contribute to higher final grain yields.

Table 6: Effect of nitrogen strategy and variety (fungicide treatment 2) on green leaf area (m2) per m2 at GS55 in Baudin, Gairdner and VB 0229 – 2nd October

Nitrogen regime	*Fungicide trt 2.*	*Variety*		
		Baudin	VB 0229	Gairdner
75 N - Seedbed	Mean	**2.24**	**2.33**	**1.74**
75 N – GS30	Mean	**1.88**	**2.15**	**1.75**

Quality

Influence on Protein

Protein content from the later nitrogen timings were significantly lower than those associated with seedbed nitrogen. The experimental variety VB0229 did produce significantly lower grain protein content than Baudin and Gairdner. The higher grain protein content with Gairdner is likely to have been linked with the low plant populations and generally lower yields.

Table 7: Grain protein percentage associated with individual nitrogen and fungicide treatments, with classification indicated in brackets based on grain protein and screenings percentage (data shown in table 8) and acceptable test weights (data not presented).

Nitrogen regime	*Fungicide treatment.*	*% Protein*		
		Baudin	VB0229	Gairdner
Seedbed	Untreated	14.2 (F2)	14.2	16.1 (F2)
	1 Spray GS30	13.5 (F2)	13.2	15.1 (F1)
	1 Spray GS49	13.9 (F2)	13.9	15.0 (F2)
	2 Spray GS30+49	13.7 (F2)	13.8	15.3 (F2)
	Mean	**13.8**	**13.8**	**15.4**
GS30	Untreated	13.7 (F2)	13.0	14.4 (F1)
	1 Spray GS30	13.3 (F1)	12.5	14.3 (F1)
	1 Spray GS49	13.6 (F2)	12.4	14.0 (F1)
	2 Spray GS30+49	13.5 (F1)	12.5	14.3 (F1)
	Mean	**13.5**	**12.6**	**14.3**
Overall Mean		**13.7**	**13.2**	**14.8**
LSD – variety means			**0.4**	
LSD – Nitrogen timing/variety means			**0.6**	
LSD – Nitrogen timing/variety/fungicide			**1.3**	

Since VB0229 is not a proven commercial malting variety it has not been ascribed a market grade, however it is worth noting that its low protein trait has in this trial ensured that it would have been the only variety to have been classed as malting, albeit lowest grade due to screenings over 10%.

Influence on % Screenings (2.2mm screen)

There was a general trend for screenings to be higher where seedbed nitrogen was applied, this was statistically significant if all 3 varieties were averaged (18.9% compared to 12.8%), and in effect making the difference between F1 (feed 1) receival standard and F2 standard feed 2. The low screenings recorded with Gairdner are again most likely to have been related to the lower plant population produced in these plots. Though, it is not statistically significant the GS30 fungicide application reduced screening levels compared to the later timing and untreated plots.

Table 8: Percentage screenings (passing through a 2.2mm screen) associated with individual nitrogen and fungicide treatments

Nitrogen regime	*Fungicide treatment.*	*% Screenings (2.2mm)*		
		Baudin	VB0229	Gairdner
Seedbed	Untreated	22.8	15.1	23.3
	1 Spray GS30	19.1	14.3	12.2
	1 Spray GS49	24.4	21.3	18.8
	2 Spray GS30+49	21.1	16.7	17.5
	Mean	**21.9**	**16.9**	**18.0**
GS30	Untreated	19.8	11.6	11.5
	1 Spray GS30	7.6	14.0	11.0
	1 Spray GS49	18.7	14.4	10.2
	2 Spray GS30+49	11.0	11.6	11.8
	Mean	**14.3**	**12.9**	**11.1**
Overall Mean		**18.1**	**14.9**	**14.6**
LSD – variety means			**4.0**	
LSD – Nitrogen timing/variety means			**5.6**	
LSD – Nitrogen timing/variety/fungicide			**11.3**	

Test weights in the trial ranged from 66.4 kg/hl to 70 kg/hl and in this trial and did not affect the barley grade as defined by the receival standards.

Interpretation

Overall, looking at the mean of the three varieties, GS30 applied nitrogen produced significantly higher yields (0.11 t/ha) than seedbed nitrogen, however it was not possible to conclude that there was a response to applied nitrogen, since there were no zero nitrogen plots.

Unlike the 2005 results, protein levels were not increased by the later GS30 nitrogen applications, in fact GS30 application resulted in lower grain protein. In part, this result may have been due to slightly higher yields associated with this timing, particularly with Gairdner and VB0229. However it is also possible that not all the nitrogen applied at GS30 was available to the crop, a fact that would have also registered lower grain protein levels. Lack of following rainfall after the August 10th GS30 applications may have resulted in a degree of volatilization however with an untreated crop for comparison it is difficult to make firm conclusions.

Again in contrast to the 2005 season there was no trend for later nitrogen to reduce fungicide response compared to seedbed nitrogen, principally due to the overall lack of disease in the trial. None of the fungicide programs gave any statistically significant yield increases and though there was a trend, particularly with Baudin and VB0229 for fungicide treated plots to be higher yielding, with 3% and 4% yield responses respectively. This trend resulted in small gross margin advantages particularly with the GS30 applications, but it was not possible to correlate this with Spot Form of Net Blotch (SFNB) differences during grain fill. It should also

be emphasized that these margin differences are based on some significant yield differences in nitrogen timing but none in terms of fungicide application.

Table 9: Value of output ($/ha) after fungicide costs have been removed.

Nitrogen	*Fungicide*	*Output after fungicide cost ($/ha)*			
		Baudin	Gairdner	VB 0229	**Mean**
Seedbed	Untreated	393	261	381	**345**
	1 Spray GS30	386	314	359	**353**
	1 Spray GS49	428	238	349	**339**
	2 Spray	365	266	318	**316**
	mean	**393**	**270**	**352**	
GS30	Untreated	417	345	381	**381**
	1 Spray GS30	440	326	437	**401**
	1 Spray GS49	405	308	399	**371**
	2 Spray	356	286	386	**343**
	mean	**404**	**316**	**401**	

Notes: Output value takes account of application cost ($3.50/ha) and wheeling damage for GS49 applications only (2.5%). Feed barley grain is priced at $300/t. Tilt/Bumper was costed at $7/ha for a 250ml/ha application.

Commercial Practice

In the 2005 season, when trial yields were in the 3-4t/ha range, delayed nitrogen increased both yield and grain protein content of malting barley compared to seedbed application. The 2006 equivalent results, in which only feed barley was produced, also illustrated a small yield benefit to GS30 nitrogen, but with no increase in grain protein compared with seedbed application.

With such a low yielding season it is difficult to make firm conclusions, other than to point out that delayed nitrogen application produced better yield and quality than the seedbed applied equivalent. The quality results are the opposite of all our 2005 trial work. Of course, despite the very low soil nitrogen status (25kg/ha N – 0 -60cm) it is likely that no applied nitrogen was necessary to produce the low yields recorded, illustrating the other key benefit of the delayed nitrogen application, i.e. if the seasonal prospects have deteriorated the nitrogen doesn't have to be applied in a commercial situation.

The work also illustrated that in such extreme seasons final above ground dry matter at harvest is not necessarily an indication of yield potential, as smaller crop canopies created by later timed nitrogen correlated to superior yields and an indication of higher harvest index (greater % of dry matter as grain).