Yield response of wheat to differing Nitrogen rates and timings under Tasmanian conditions

With Nitrogen being the key limiting nutrient in wheat production, it is important for growers to understand how their chosen wheat variety is likely to respond to different nitrogen regimes to achieve optimum yield and grain quality for market.

Following on from Nitrogen response work done in Tasmania in 2013, Southern Farming Systems set up replicated small plot trials at two sites in Tasmania; Cressy, Northern Midlands; and Don, North West coast; to further test the response of different wheat varieties to varying rates and timings of Nitrogen applications.

Each site was analysed for affects among the treatments.

Part I: Assessing growth and yield responses to varying nitrogen rates and timings in Revenue and Trojan wheat sown under irrigation in the Northern Midlands

Cressy Focus Site – Pisa Estate, MacQuarie Rd, Cressy Tasmania

Heather Cosgriff, Southern Farming Systems; David Kohler, Peracto

Key Messages

- Trojan apparently responded better to 3 Nitrogen applications at GS 31, 33 & 37
- Revenue yielded most will nil extra Nitrogen, but not significantly better than with 100kg applied urea
- Higher Nitrogen late increased grain protein across all varieties as expected
- Revenue expressed reduced yields at Urea application rates higher than 200kg/Ha

References

"Nutrient Management in Broadacre Cropping", SARDI/CropCo.
"Growing eight tonnes a hectare of irrigated wheat in Southern NSW", NSW DPI Primefact No. 197, 1996.

Trial Design

Revenue and Trojan wheats were selected for the Cressy site, with Revenue being a district standard, and Trojan a promising new variety.

Soils samples were taken at the Cressy site to three depths at an untreated portion of the site to assess the amount of available Nitrogen in the soil, and Urea applications made throughout the season as per the treatment list shown in Table 1 below.

Table 1. Treatment list Cressy Focus Site.

Variety	N Timing (kg urea/ha)					
	14 Jul	25 Aug	19 Sep	23 Sep	22 Oct	Total
Revenue	**GS25**	**GS27**	**GS31**	**GS32**	**GS45**	
Revenue						**0**
Revenue		100				**100**
Revenue		100	100			**200**
Revenue		100	100	100		**300**
Revenue		100	100	100	100	**400**
Revenue	100	100	100	100	100	**500**
Revenue		150	150	100	100	**500**
Revenue	100	150	150	100	100	**600**
Revenue*		100	100	100	100	**400**

Trojan	GS25	GS31	GS33	GS37	GS59	
Trojan						**0**
Trojan		100				**100**
Trojan		100	100			**200**
Trojan		100	100	100		**300**
Trojan		100	100	100	100	**400**
Trojan	100	100	100	100	100	**500**
Trojan		150	150	100	100	**500**
Trojan	100	150	150	100	100	**600**

*ZincStar 100 kg/ha applied at sowing.

Other Crop Inputs

Fertiliser: MAP 100 kg/ha at sowing (except *)

Herbicide: Precept 1.5 L + Hasten 1% on 25 June
Axial + Kwiken 300 mL + 500 mL/ha

Fungicide: Prosaro 200 mL/ha
Cogito 250 mL/ha 4 weeks later
Folicur + DC-Trate 290 mL + 1% 2 weeks later

PGR: Moddus + Errex 200 mL + 1.2 L/ha

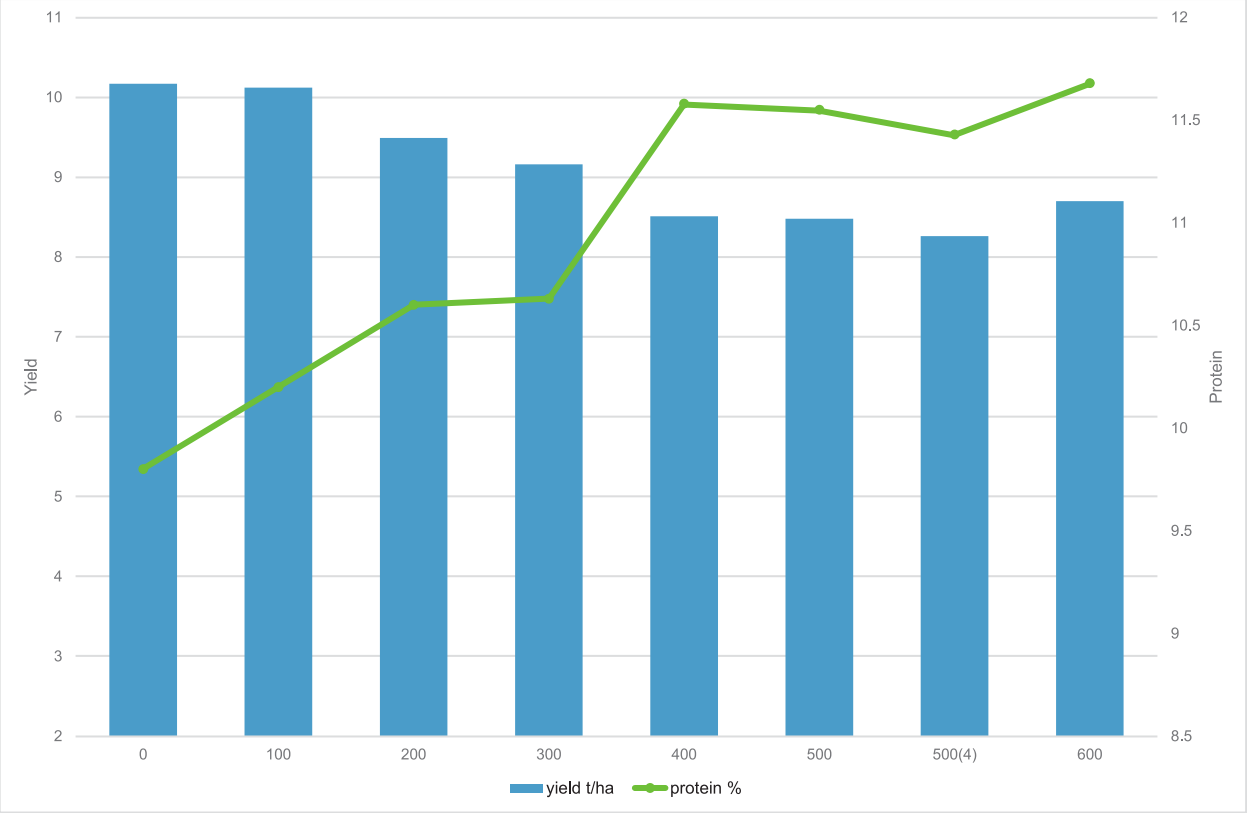
Irrigation: 25mm per week (approx.) from late October to December totalling 300mm.

Results

Trojan wheat responded differently to Revenue to timing and rate of Nitrogen (N) application under irrigation at Cressy.

Revenue wheat yields generally decreased with additional Nitrogen applications, as demonstrated in Figure 1. Revenue wheat yield was highest, at just over 10 t/Ha, with nil applied Nitrogen, or with 100kg of Urea applied at Zadocks growth stage 27.

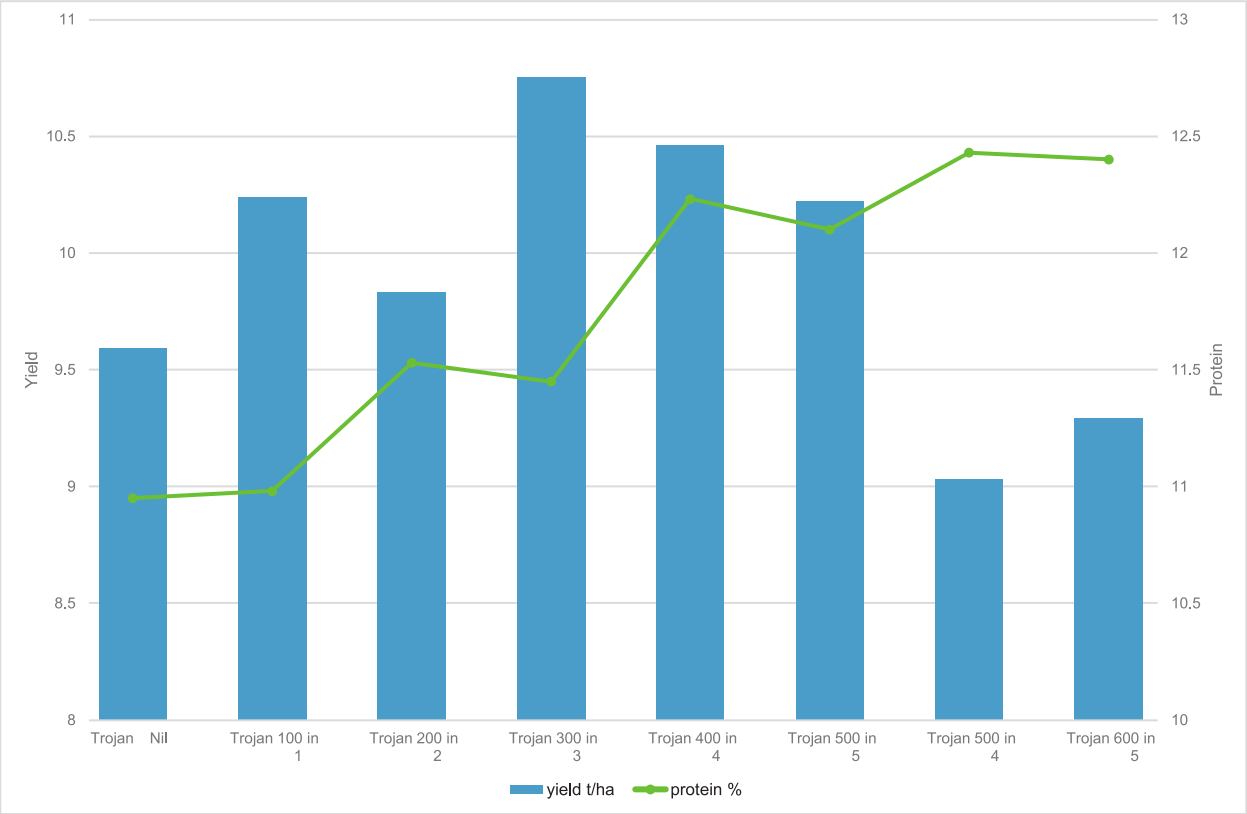
Figure 1. Revenue wheat grain yield and protein response to varying Nitrogen rates, Cressy.



Trojan wheat achieved the highest yield overall at 10.75 t per Ha. This was achieved with 3 applications of 100kg of Urea at Zadocks growth stages Z31, Z33 and Z37. Yields decreased significantly (P=0.5) when applied Urea exceeded 400kg per Ha, see Figure 2.

As displayed above in Figure 1, and in Figure 2 below, grain protein increased with higher and later rates of Nitrogen application, as would be expected.

Figure 2. Trojan wheat grain yield and protein response to varying Nitrogen rates, Cressy.



Soil tests taken prior to sowing showed that this site had high levels of available soil Nitrogen to a depth of 90 cm, with more than 200kg/ha available, see Table 2 below. While some lateral movement of Nitrogen applied to other trial plots could have occurred, it can be assumed that most of the soil Nitrogen was there at sowing.

Table 2. Available Nitrogen at Pisa Focus Site 4th April 2014

Site	Soil Depth	NO3-N	NH4-N	Total available N
	cm	kg N/ha	kg N/ha	kg N/ha
Cressy	0-30	103.32	1.8	105.12
Cressy	30-60	37.05	1.95	39
Cressy	60-90	30.96	3.6	34.56
Total		**171.33**	**7.35**	**178.68**

A mineralised Nitrogen figure was also calculated using a soil carbon level of 2.13%, average growing season rainfall of 432mm and a % efficiency figure. At 50% = 69kg N/ha, at 75% with irrigation = 104 kg N/ha.

If we assume that Wheat, on average, uses 20 – 25kg of Nitrogen per tonne of grain yield, there was enough Nitrogen already available in the soil to target an 8 t/Ha yield.

According to research, high Nitrogen availability at sowing can lead to increased vegetative growth in wheat, and this combined with a high seeding rate can lead to lodging and associated yield losses. It can also be a trigger for increased infection rates of foliar diseases such as Septoria tritici and mildew, which may also reduce yields.

With Revenue wheat being susceptible to leaf diseases, the lack of yield response to further nitrogen inputs in this trial could relate to increased disease levels or to higher rates of lodging.

Interestingly, Trojan wheat did show a yield response to Urea applications up to 300kg (total extra Nitrogen applied 138kg/ha). With the improved disease resistance package of the new variety, plants may have been better able to utilise the extra Nitrogen therefore increasing yield while maintaining grain protein at an optimal level close to 11.5%.

Part II: Assessing growth and yield responses to varying Nitrogen rates and timings in dryland sowing of Beaufort wheat on the Northwest coast of Tasmania

Don Focus Site – Don Focus Site, Forth Rd. Don

Heather Cosgriff, Southern Farming Systems; David Kohler, Peracto

Key Messages

- Highest yield for Beaufort was 9.05 t/Ha
- Highest yield was achieved with 100kg of applied Urea at GS 30
- Higher Nitrogen late increased grain protein across all varieties as expected
- For this site Beaufort expressed reduced yields at Urea application rates higher than 200kg/Ha

Acknowledgements

SFS would like to acknowledge Botanical Resources Australia (BRA Ltd) for their support by provision of land for the Don Focus Site as well as machinery and labour for working ground.

References

"Nutrient Management in Broadacre Cropping", SARDI/CropCo.
"Growing eight tonnes a hectare of irrigated wheat in Southern NSW", NSW DPI Primefact No. 197, 1996.

Trial Design

Beaufort wheat was sown into a pyrethrum stubble between Forth and Don. Beaufort was used as the district standard feed wheat for the Northwest Coast.

Soils samples were taken at the Don site at three depths to assess the amount of available nitrogen at sowing, and Urea applications made throughout the season as per the treatment list shown in Table 3 below.

Table 3. Treatment list, Don Focus Site.

		N Timing Zadoks GS. Kg Urea/Ha				
Treatment	**Trt Code**	**22**	**30**	**32**	**39**	**Total Urea**
1	0					**Nil**
2	100		100			**100**
3	200		100	100		**200**
4	300	100	100	100		**300**
5	400	100	100	100	100	**400**
6	500	100	150	150	100	**500**
7	600	150	150	150	150	**600**

Other Crop Inputs

Fertiliser: MAP 100 kg/ha at sowing

Herbicide: Precept 1.5 L + Hasten 1% on 25 June
Axial + Kwiken 300 mL + 500 mL/ha

Fungicide: Prosaro 200 mL/ha
Cogito 250 mL/ha 4 weeks later
Folicur + DC-Trate 290 mL + 1% 2 weeks later

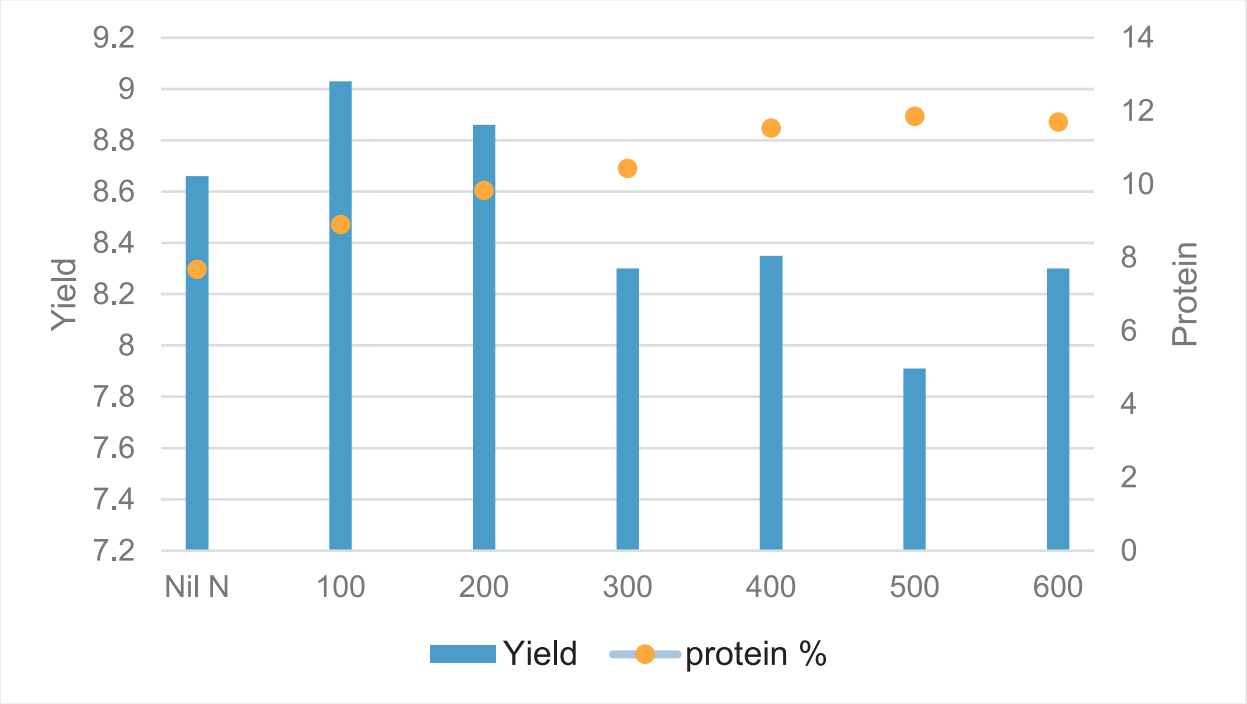
PGR: Moddus + Errex 200 mL + 1.2 L/ha

Site not irrigated

Results

The highest yield of Beaufort wheat was 9.05 t/Ha when 100kg of Urea was applied at Z30, result was only just significant at P=0.5. Grain protein increased with higher and later rates of Nitrogen application, as would be expected. A visual summary of the results can be seen in Figure 3 below.

Figure 3. Beaufort wheat grain yield and protein response to varying Nitrogen rates, Don Focus Site.



Soil tests taken before sowing showed 51kg/Ha of available Nitrogen in the soil to a depth of 60cm.
11 kg of Nitrogen was applied at sowing, giving a total of 65 kg Nitrogen per hectare for early crop growth.

As previously stated, wheat removes approximately 20 – 25kg of Nitrogen per tonne of grain yield, therefore to target a yield of 10 t/Ha at least 250kg of Nitrogen needs to be available to the plants up to late tillering.

Interestingly, at the Don site a yield of just over 9 t/Ha was achieved with only 111kg/Ha of applied and measured soil available Nitrogen, and available Nitrogen rates over 150 kg/Ha resulted in decreased yields and increased grain protein. High levels of potentially mineralisable Nitrogen (PMN) from the previous crop residue (in this case pyrethrum) may have had a hand in this. The deep Nitrogen test results are shown in the Table 4 below, and the potential upside in PMN of 230 kg / Ha would be more than enough to sustain the higher yields once soil temperatures warmed up in the spring and this Nitrogen became available to wheat plants.

Table 4. Soil Nitrogen availability for Don Site.

Site	Soil N (0-90cm)	NO3-N	NH4-N	Total N per depth	Total avail N
	kg N/ha	kg N/ha	kg N/ha	kg N/ha	Kg N/ha
Don	0-30	39.3	1.8	41.2	
Don	30-60	9.24	1.65	10.89	
Don	60-90	4.62	0.66	5.28	57.37

A mineralised Nitrogen figure was also calculated using a soil carbon level of 4.55%, average growing season rainfall of 511mm and a % efficiency figure. At 50% = 230kg N/ha, at 60% with high rainfall = 276 kg N/ha.

Conclusion

Across both trial sites wheat yields in the older varieties Revenue and Beaufort decreased when Nitrogen was applied in amounts greater than 200kg per Ha. This would suggest that other factors are preventing these varieties from utilising increased Nitrogen availability to maximise yield, and this is most likely to be increased incidence of foliar disease.