Wheat yield and its components in response to early sowing and nitrogen fertiliser rate

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Key findings

- Early sowing increased grain yields in all of the wheat varieties trialed, however, the size of the increase was dependent on the variety.
- Nitrogen application increased grain yield in the early sown treatments and increased grain protein especially in late sown crops.

Why do the trial?

Nitrogen (N) management remains one of the most important and risky decisions for farmers in South Australia. Decisions need to be made about both the timing and the quantity of N fertiliser. New practices such as early sowing and the use of new wheat varieties are likely to alter crops N fertiliser needs and farmers will need to adjust their N management accordingly.

Early sowing is receiving more attention as it has the potential to increase yields in years and locations with low frost risk. Nitrogen management has to be adjusted to capture the higher yield potential and maintain grain protein of early-sown crops. Porker and Wheeler (2014) found that in some barley varieties, if sown early, delaying N application could increase protein content without yield penalty. However, if sown later, delayed N application still increased protein but also resulted in a significant yield penalty. For other varieties they found that earlier N application was preferred. These findings suggest that nitrogen management has to account for both sowing time and variety. Therefore, there is an emergent need to refine N management for specific wheat varieties and in relation to sowing time to maximise yield, grain protein, N use efficiency and thus reduce financial risk.

The results presented here are part of a larger three year GRDC project to develop a benchmark (a nitrogen dilution curve) which will be used to accurately determine crops' N status. Our final aim of this trial is to determine how a crops' N status changes in relation to early sowing and variety. At time of this publication, the nitrogen dilution curve which is needed to determine crop N status is still under development. However, we present our preliminary results of the effects of sowing time, N application and variety on biomass, yield and yield components.

How was it done?

Plot size:	1.75 m x 10.0 m
Seeding dates:	30th of April and 26th of May 2015
Seeding rate:	210 plants / m2
Fertiliser (urea N):	0 kg N/ha 60 kg N/ha split between seeding and beginning of tillering (GS20)
Initial mineral soil N:	30th of April: 89 kg N/ha
(0-100 cm soil layer)	26th of May: 123 kg N/ha
Wheat varieties:	Mace, Axe, Scout, Trojan, Spitfire and Cobra.

Methods

The trial had a randomised block design with 2 sowing dates, 6 wheat varieties, 2 N rates and 3 replicates. Soil samples were taken the day before, or on the day of sowing for each sowing date. Soil was sampled up to 1 metre deep in 20 cm layers and analysed for initial soil moisture and N content.

Biomass was sampled in two rows of 50 cm at anthesis and 2 rows of 1 metre at maturity. The biomass was oven dried at 60°C and weighed. The samples taken at anthesis were analysed for total shoot N. The samples taken at maturity were separated into ears and remaining shoot. The remaining shoot was analysed for N content and the ears were used for determination of yield and yield components: 1000-grain weight, number of ears per m2, harvest index (i.e. grain weight / total biomass), screenings and protein content.

Effects of variety, sowing date and N fertiliser rate on biomass, yield and yield components was statistically tested using three-way-ANOVA at a 5% significance level.

Results and Discussion

Grain yield and protein

Grain yield was affected by variety, sowing time and N application, with some interactive effects (Figure 1). Yield differed among varieties, with lowest yields for Axe and Spitfire (2.4 t/ha average of all treatments) and highest yields for Trojan (3.1 t/ha), Mace and Scout (2.9 t/ha).

Overall, early sowing increased yield, however the increase was larger for some varieties than others. For example, Trojan and Spitfire (under the 60 kg N/ha treatment) increased by 1.6 and 1.0 t/ha respectively, while Axe and Mace only increased yield by 0.2 and 0.3 t/ha respectively under the same N fertiliser rate. This can partly be attributed to the difference in cultivar maturities. Axe (early maturing) and Mace (mid - early maturing) are both earlier maturing than Trojan and Spitfire which are mid - long season maturing varieties and can thus make use of a longer season, especially when sown early.

Nitrogen application only increased yields in the early sowing treatment (Figure 1). In the late sowing treatment, N application did not increase yield. In contrast, grain protein increased with N fertiliser, but the increase was larger in the late sown treatment (3.9%, averaged for all varieties) than in the early sown treatment (1.4%, Figure 2).

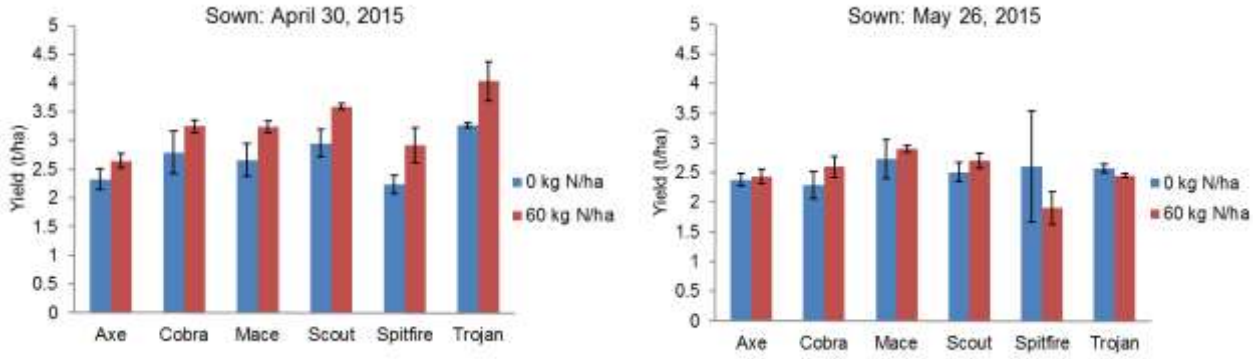

Figure 1. Effect of N fertiliser on yield for early (April 30) and late (May 26) sowing. Error bars represent 2 standard errors.

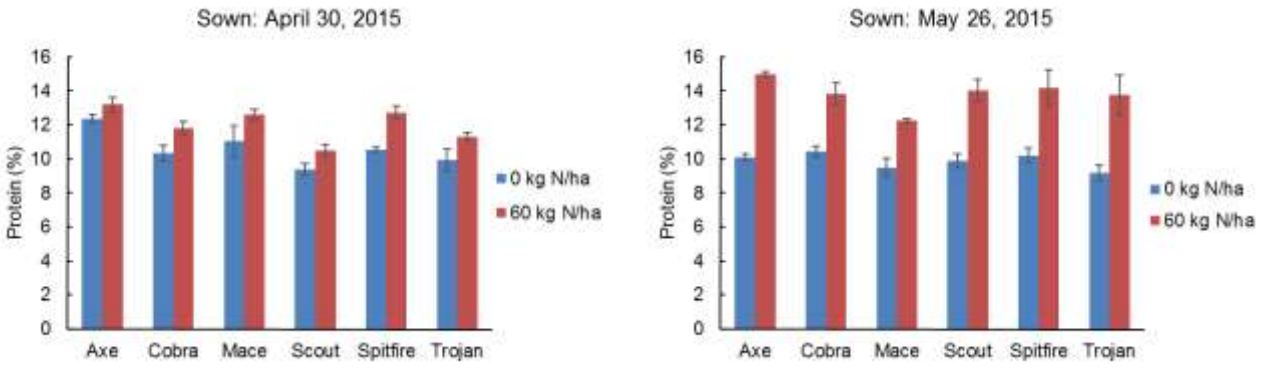

Figure 2. Effect of N fertiliser on grain protein for early (April 30) and late (May 26) sowing. Error bars represent 2 standard errors.

Yield components

Biomass and the number of ears per m^2 (i.e. tillering) increased with N fertiliser at both early and late sowing times. However, 1000-grain weight decreased and screenings increased with N fertiliser in late-sown crops (Table 1). In other words, N fertiliser increased the number of ears per m^2, but in the late sown crop, because of the shorter growing season, there was likely not enough time to fill the additional grain, resulting in higher screenings, lower 1000-grain weight and no yield increase. The smaller grain size in the late sown, 60 N treatment, increased the concentration of protein in the grain, which is commonly observed.

Table 1. Biomass at anthesis, harvest index, screenings, 1000-grain weight and number of ears per m^2, per sowing time and N treatment.

	Biomass at anthesis (t/ha)		Harvest Index		Screenings (%)		1000 grain weight (g)		# ears /m^2	
Early sowing										
	0 N*	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**
Axe	4.34^{a}	5.28	0.38^{c}	0.40^{ab}	0.20	0.44	38.49^{b}	37.34	248	281
Cobra	4.47^{a}	5.06	0.43^{abc}	0.46^{a}	0.18	0.53	40.77^{ab}	36.99	223	276
Mace	4.61^{a}	4.96	0.40^{abc}	0.40^{ab}	0.11	0.28	42.49^{a}	40.90	231	288
Scout	4.00^{a}	5.25	0.44^{ab}	0.46^{ab}	0.10	0.20	41.71^{ab}	39.77	246	276
Spitfire	3.11^{b}	4.89	0.39^{bc}	0.38^{b}	0.17	0.66	43.97^{a}	41.36	230	305
Trojan	4.58^{a}	5.48	0.45^{a}	0.46^{a}	0.06	0.77	42.89^{a}	37.79	268	304
Late sowing										
	0 N	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**	**0 N**	**60 N**
Axe	3.42	4.84^{ab}	0.43	0.39^{ab}	0.33	4.92	36.66^{a}	28.81^{ab}	252	305
Cobra	4.05	5.50^{ab}	0.44	0.39^{ab}	0.91	13.83	31.17^{b}	25.69^{b}	219	285
Mace	4.19	5.52^{a}	0.45	0.42^{a}	3.37	24.30	34.28^{ab}	28.11^{ab}	221	268
Scout	4.95	5.75^{a}	0.40	0.38^{ab}	10.29	19.74	33.84^{ab}	26.74^{ab}	247	271
Spitfire	3.51	4.38^{b}	0.51	0.32^{b}	3.91	17.51	36.69^{a}	30.65^{a}	229	293
Trojan	3.71	5.76^{a}	0.42	0.38^{ab}	0.31	14.76	36.49^{ab}	29.10^{ab}	212	262

*N rate in kg N/ha

Conclusions

In general, for the varieties trialed, early sowing (in absence of frost) increased grain yield. Nitrogen application increased the number of ears per m^2. In the early sowing treatment, this resulted in significantly higher yields compared with the 0 N treatment. However, in the late sown treatment, the season was too short to fill all grains which resulted in no yield increase, higher screenings, lower 1000-grain weight and higher grain protein, compared with the 0 N treatment.

Acknowledgements

The authors thank GRDC for project funding (project DAS00147) and Hart staff for managing the trial.

References

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Special guest speaker, Dr Heather Bray delivers her lunch time address at the 2015 Hart Field Day