Southern barley agronomy – how much nitrogen is too much, and when should I apply it?

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Take home messages

- Westminster was the barley variety that gave the top gross margin with an application rate of 120 kg N/ha at GS31, closely followed by GrangeR (90 kg N/ha at GS31).
- Oxford (45, 90 or 120 kg N/ha at GS31) yielded equal top with Westminster but the gross margin was hurt by the price difference between malt and feed barley varieties at the time of writing this report.
- Application of N at GS31 gave significantly higher yields compared to application at GS22, across all varieties and N application rates.
- The most cost effective rate to consistently receive the highest yields was 90 kg N/ha.
- Oxford was consistently the highest performer and the best choice for those who rarely make malt grade on their soils.

Introduction

The theory behind delaying nitrogen application until growth stage 31 (GS31), stem elongation, is that we are able to better manage canopy size as a part of the Tactical Nitrogen Strategy (TNS) described by GRDC. The underlying principle of the TNS is that with the delaying of nitrogen application until stem elongation, in years of drought it has allowed for significant financial savings because the season outlook at this point will be far more accurate than at growth stage 22 (GS22), tillering.

The purpose of this trial was to investigate the effects of delaying nitrogen application until GS31 on grain yield and quality by using differing nitrogen application rates across a range of popular malt and feed barleys.

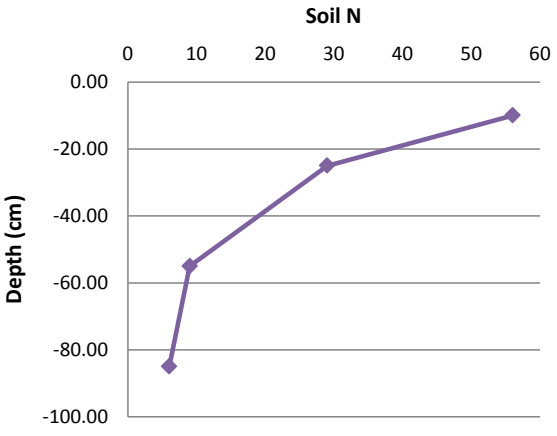
Method

The trial was sown at Westmere on the 28/5/13, using the SFS cone seeder on 200 mm row spacings, using 25 mm knifepoints, and with a target plant population of 180 pl/m^2. Further agronomic details are show in Table 1, while initial soil nitrogen levels are shown in Figure 1. The trial compares the four barley varieties GrangeR, Henley, Westminster (malt) and Oxford (feed) at five nitrogen application rates (45, 90, 120 and 240 kg N/ha) applied as Urea at either GS22 (tillering) or GS31 (stem elongation). The trial was managed according to best practices with regards to pests, weeds and disease control. The dry summer followed by a decile 6 growing season rainfall meant that we were able to optimise yield potential as we had minimal waterlogging over the winter, excellent October rainfall and no extremes of temperature. After a late break to the season and warmer than average winter temperatures crops grew well through the winter and developed deep root systems which would help them find moisture at the end of the season in November. Disease levels were kept under control with two fungicides timed at GS32 (second node) and GS49 (awns emerging). The ryegrass and wild radish were well controlled with Boxer Gold PSPE and a post emergence application of Precept in June. The trial was harvested on the 29/12/13.

Table 1. Agronomic and management details for Westmere trial.

Previous crop	Wheat	
Soil type	Clay	1.7% Org C
Sowing date	28 May 2013	
Soil Mineral Nitrogen	June 2013	100 kg N/ha
N applications	28 May	MAP 80 kg/ha (8N)
GS22 (tillering)	24 July	Urea @ 100 kg/ha, 200 kg/ha, 260 kg/ha, 560 kg/ha
GS31 (first node)	28 August	Urea @ 100 kg/ha, 200 kg/ha, 260 kg/ha, 560 kg/ha

Figure 1. Initial soil nitrogen levels to a depth of 90 cm.



Results and Discussion

The effect of timing of nitrogen application had a significant impact on yield for all varieties except Henley. Oxford had the most significant increase where the average yield when nitrogen was applied at GS31 was 9.24 t/ha compared to 8.79 t/ha when nitrogen was applied at GS22 (Figure 2). These results were for all nitrogen application results combined.

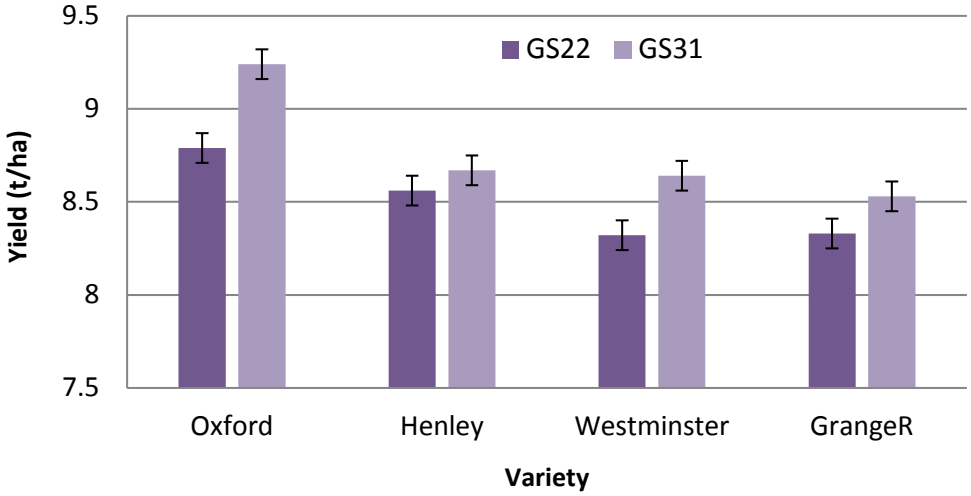


Figure 2. Effect of N application at GS22 compared to GS31. (p=0.030, LSD=0.16)

Application of nitrogen at GS31 gave significantly higher yields at the rates 90, 120 and 240 kg N/ha when compared to application at GS22 and averaged across all varieties. There was no significant difference between the three applications rates at the later growth stage. In fact, yields were significantly higher with only 90 kg N/ha at GS31 compared to 120 or even 240 kg N/ha applied at GS22. The effect of rate of application of nitrogen (averaged over both growth stages) on protein levels is shown in Figure 3. There was a detrimental effect of application of 240 kg N/ha at both growth stages, where protein levels were pushed too high to make malt quality. Clearly this is not a problem for the feed variety Oxford, but considering it will achieve equal yields at 90 kg N/ha there is no need to apply a higher rate.

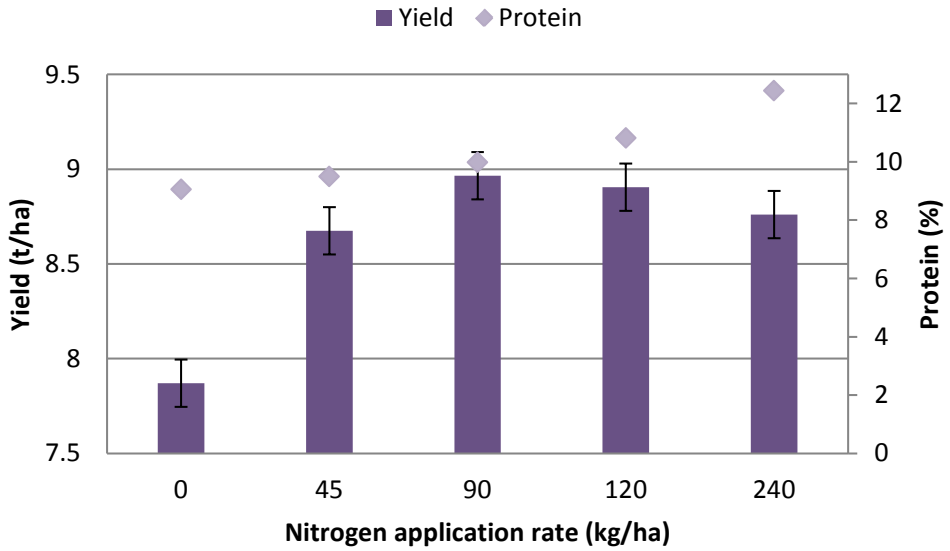


Figure 3. Effect of rate of application of nitrogen on protein levels. (p=0.003, LSD=0.25)

Oxford gave equal highest yields whether applying 45 or 90 kg N/ha. It was also the standout top performer at any nitrogen application rate except 120 kg N/ha (Figure 4).

It is also worth noting that Henley did not make malt quality in any situation due to low test weights, and was particularly responsive to nitrogen application with regards to protein levels; they were too low with zero nitrogen, and too high with the maximum rate. Both GrangeR and Westminster also did not make malt grade due to high protein levels.

The question that remains is, does it make economic sense to grow a malting barley when Oxford yields significantly higher with an application rate of nitrogen of only 45 kg/ha?

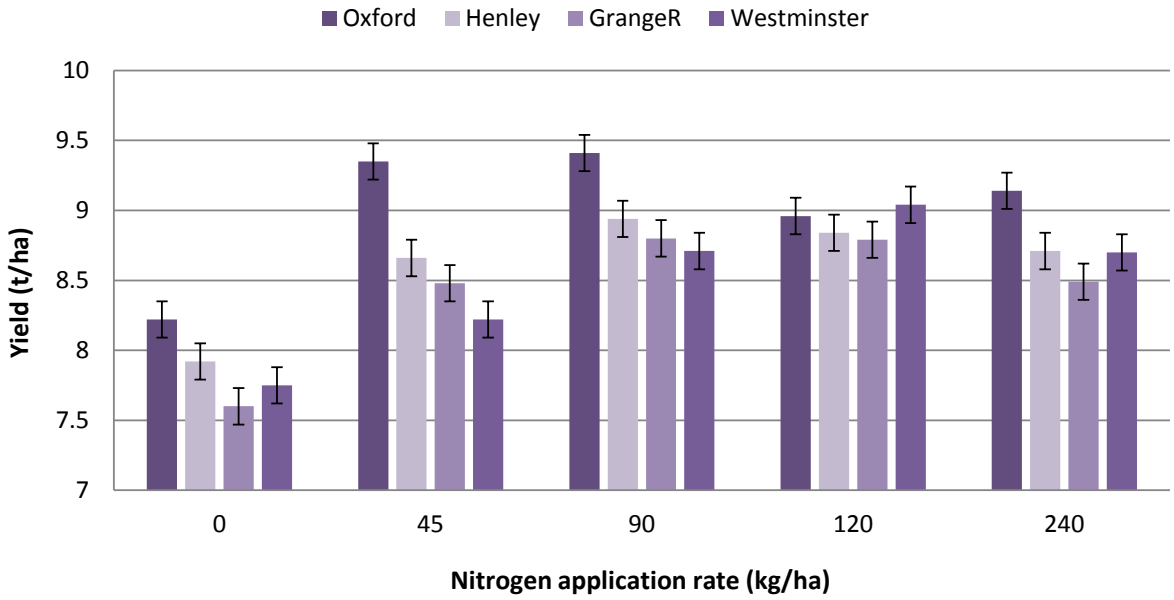


Figure 4. Effect of rate of application on variety. (p<0.001, LSD=0.26)

Oxford gave equal highest yields whether applying 45, 90 or 240 kg N/ha at GS31 or 45 kg N/ha at GS22, along with Westminster where applying 120 kg N/ha at GS31 (Figure 5). With zero nitrogen added at GS31, both Henley and GrangeR had protein levels that were too low to make malt grade. Application of 240 kg N/ha at GS22 on Westminster and GrangeR, and at GS31 on Westminster and Henley, gave protein levels that were too high to make malt.

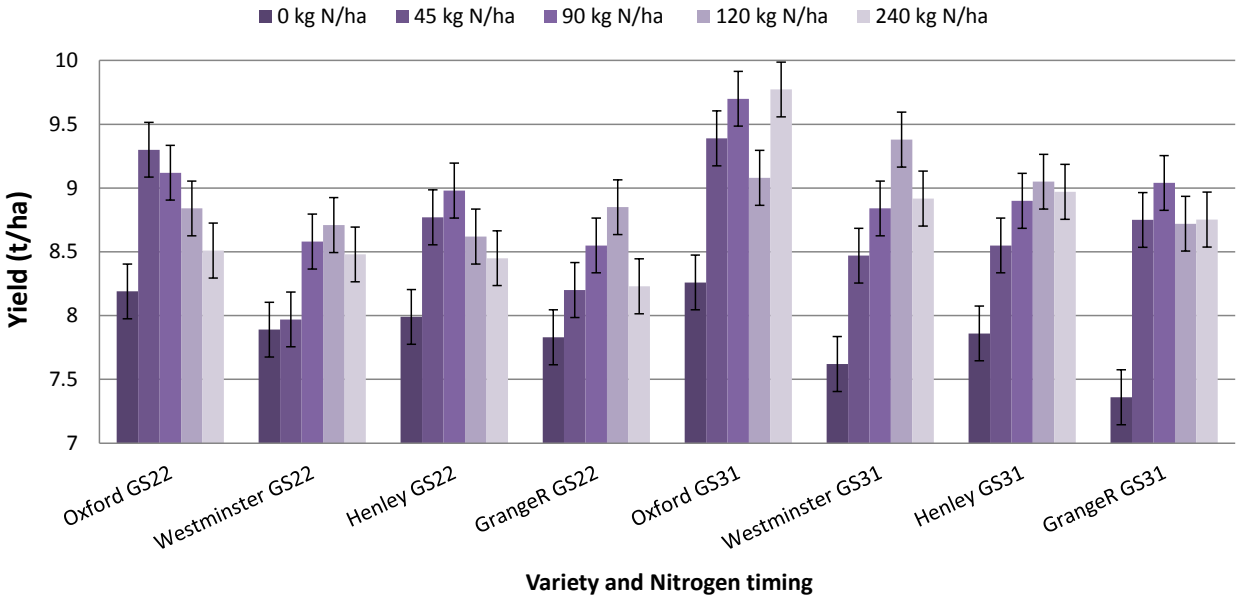


Figure 5. Yield response of each variety to increasing nitrogen rates at two times of application. (p=0.027, LSD=0.43)

Commercial Application

In this trial, Westminster, closely followed by GrangeR, was the most profitable variety to grow as they made malt quality. Oxford yielded statistically the same but a lower price; the feed variety fell short on profit. It is important to note that Oxford was capable of achieving outstanding yields by applying much less nitrogen (45 kg N/ha versus the 120 kg N/ha required to get Westminster to malt) (Appendix E). Timing of nitrogen application did not seem to be as crucial for Oxford, however overall, this trial shows a clear trend that GS31 is the better application time for any rate of nitrogen. Growers need to be aware that certain soil types have difficulty producing barley at the malting standard, so this trial suggests that Oxford is a flexible option that could prove to yield consistently high. Further trials are needed to determine the long-range performance of Oxford.

The mid-season biomass and NDVI assessments have shown that there is a significant correlation between the time of nitrogen application and the canopy size. Therefore, there is some merit in delaying nitrogen application until GS31 to enable better management of the canopy as a part of the TNS.

Given the particularly wet spring experienced in 2013, the results showed that application of nitrogen at GS31 had increased both yield and protein, compared to nitrogen applied only at GS22. The most profitable rate was seen with Westminster at 120 kg N/ha at GS31, however malt grade was also achieved with 45 and 90 kg N/ha at GS31 with GrangeR and Westminster.

While nitrogen application rates and timing are important for grain quality, there is also a lot of value in the selection of the variety. Some soils will always struggle to produce a malt grade barley due to soil type, moisture and soil nitrogen. Feed barley Oxford was consistently high in terms of yield and was either equal top or top in all situations, while Westminster and GrangeR were the best performing varieties that achieved malt grade.

Acknowledgements
This project was funded by the GRDC.

Important Notes
Henley has been withdrawn from the market by Heritage Seeds due to the risk of blue aleurone. It will not be offered for sale in 2014.