



Nitrogen in irrigated wheat

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- Applying nitrogen at stem elongation appears to be the best general strategy for irrigated wheat in fields with low levels of soil fertility. Applying 120 kg N/ha at stem elongation produced good yields with minimal risk of lodging.
- In fields with higher levels of soil fertility, nitrogen application should be delayed until the awns are visible, as this strategy produced the highest yields with minimal lodging.
- Grain protein levels increased with increased rates of applied nitrogen and the application of nitrogen at the awns visible stage was the most effective application time for increasing grain protein levels.
- The main factor affecting wheat yield and grain protein was the amount of nitrogen in the crop, regardless of whether it came from natural soil sources or topdressed fertiliser.

Nitrogen is a major input for irrigated wheat production and with the high cost of nitrogen based fertilisers, application rate and timing of nitrogen are crucial in maximising nitrogen use efficiency and optimising returns. Given the recent large increases in nitrogen fertiliser prices we felt it relevant to revisit what we learnt from the first large scale irrigated wheat nitrogen experiment that achieved yields above 9.0 t/ha.

A large wheat experiment was conducted on a grey self-mulching clay soil at Leeton Field Station in 1990. It consisted of three replicates with three soil fertility levels which were created by different legume and crop rotations prior to the experiment. Only the low and medium fertility levels are discussed here as they are most relevant in today's farming systems (medium and high fertility levels gave similar results).

Two wheat varieties, Wyuna, a biscuit wheat, and Yallaro, a durum wheat, were grown. Five rates of nitrogen were applied at three application times.

The application rates were 0, 30, 60, 90, 120 and 240 kg N/ha, applied as urea.

The application times were early tillering (Z15), stem elongation (Z30) and the awns visible (Z49) stages.

The experiment was sown 7 May 1990 with 105 kg/ha seed and 100 kg/ha MAP (22 P, 12 N). Establishment was excellent in all plots with an average of 200 plants/m².

Adequate rain was received during the winter and then scheduled irrigations were applied in the spring to ensure soil moisture until maturity was not limited.

Plant growth

The effect of nitrogen application timing on dry matter production is well illustrated in Figure 2, which shows the results of 120 kg N/ha applied at different growth stages on a low

and medium fertility soil. Applying nitrogen to a low fertility soil at any time will increase plant growth, but sufficient must be applied at either early tillering or stem elongation in order to accumulate the necessary dry matter to produce a high grain yield (Figure 2a).

The medium fertility soil with no addition of nitrogen produced a dry matter level similar to the low fertility soil with 120 kg N/ha applied at early tillering (Figure 2a and 2b). The addition of 120 kg N/ha to the medium fertility soil increased total dry matter above the zero nitrogen treatment but there was no significant difference in dry matter between the three times of application (Figure 2b).



Figure 1. Wheat heads nearing the end of flowering. This stage is too late to apply nitrogen but if aiming to increase grain protein applying nitrogen when the awns first become visible is the best option.

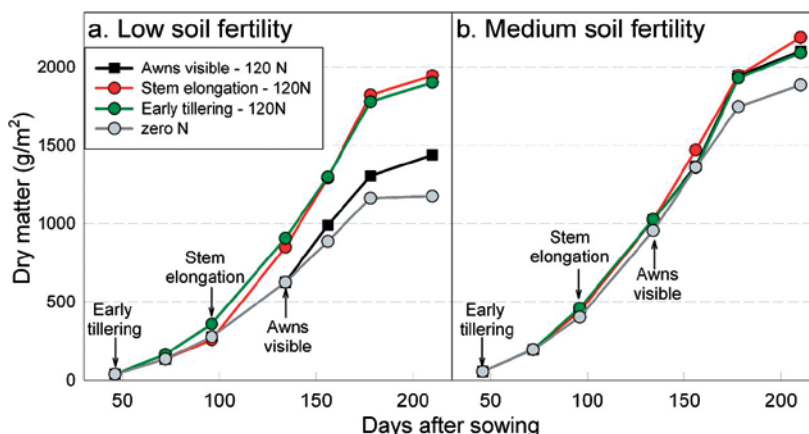


Figure 2. Dry matter production for a) low soil fertility plots and b) medium soil fertility plots with 120 kg N/ha applied at early tillering, stem elongation or awns visible growth stages (the results are the mean of varieties)

Grain yield

The grain yields were very similar between the two varieties so they are averaged for ease of explanation.

Given the high levels of dry matter produced in this experiment (up to 25 t/ha), we expected grain yields above 10 t/ha, but the highest achieved was only 9.0 t/ha. This was probably due to extremely high temperatures in late October when temperatures rose to 37°C, with three days above 35°C. The experiment however provides valuable information on the relative grain yield and protein responses to nitrogen timing applications.

Regardless of the soil fertility level, applying nitrogen at stem elongation gave the highest yield in all cases except for very high nitrogen at medium soil fertility (Figure 3).

Effect of application timing

Applying low rates of nitrogen at early tillering produced good yields for the medium fertility plots but high rates resulted in excessive growth of dry matter which resulted in lodging and reduced yield.

The low fertility plots produced a grain yield of over 8.0 t/ha when topdressed at stem elongation indicating that even in the low fertility fields there were sufficient shoots to respond to heavy topdressing.

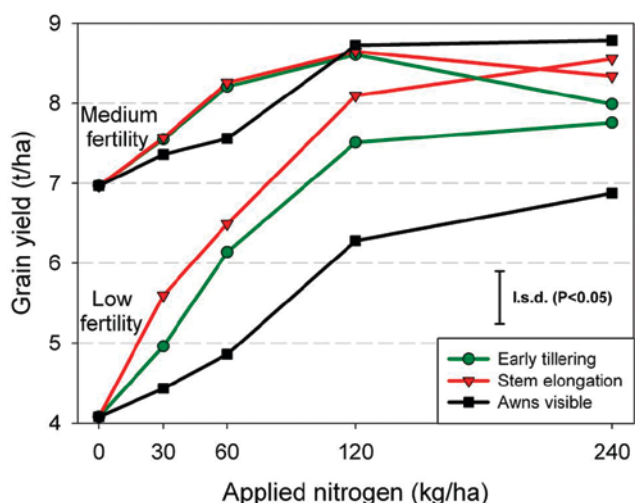


Figure 3. Grain yields for nitrogen rates and application times for low and medium soil fertility levels (the results are the mean of varieties)

Effect of application rate

For both soil fertility levels the application of 120 kg N/ha applied at stem elongation produced either the highest grain yield or at least the highest economic grain yield.

The application of 240 kg N/ha in the low fertility treatment produced only 0.46 t/ha more yield at the large cost of 120 kg N/ha.

Lodging

Lodging is a major contributor to reduced grain yield for wheat crops with high levels of dry matter. No lodging was observed in any of the treatments on the low soil fertility plots. When 120 or 240 kg N/ha was applied at either early tillering or stem elongation to the medium soil fertility plots, lodging occurred during grain filling, but no lodging occurred when nitrogen was applied at the awns visible growth stage.

Grain protein

Grain protein was increased for both varieties with increased soil fertility. The average grain protein (across all nitrogen treatments) for the biscuit wheat was 9.3 and 10.5% and the durum 9.7 and 11.2%, for the low and medium soil fertility levels respectively. As expected the grain protein of the durum wheat variety was higher than the biscuit wheat, but the trends in grain protein due to timing of nitrogen application were similar between varieties. The grain protein results for the two varieties were therefore averaged for ease of explanation (Figure 4).

Effect of application rate

Grain protein levels increased with the increased addition of nitrogen at all application times (Figure 4).

Effect of application timing

There was no difference in grain protein levels, for the same nitrogen rate, when nitrogen was applied at early tillering or stem elongation, but delaying nitrogen application until the awns were visible increased grain protein levels above the earlier application times.

The challenge with biscuit wheat is to achieve a high yield while not increasing protein above the acceptable level. This was achieved by applying nitrogen at early tillering and stem elongation and not when awns became visible.

The opposite is true for the durum wheat where high grain protein is desirable. Apply sufficient nitrogen at early tillering to

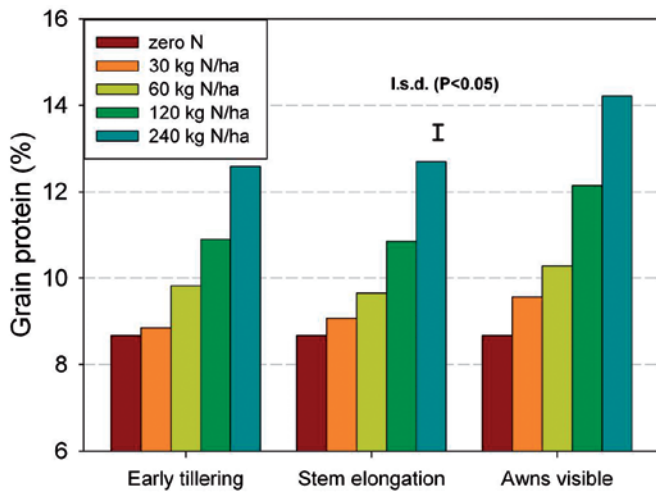



Figure 4. Grain protein for nitrogen rate and application times, averaged for variety and soil fertility levels

ensure adequate plant growth then apply more when the awns become visible. This strategy increases grain yield and protein without causing lodging.

Conclusions

In fields with a low level of soil fertility, provided plant establishment and weed control are good and the layout and water availability allow timely and adequate irrigation, the application of 120 kg N/ha applied at stem elongation is a good strategy for achieving good yields with minimal risk of lodging.

The rate and timing of nitrogen applications has a strong influence on grain protein levels. Increased nitrogen application rates increased grain protein levels and applying nitrogen at the awns visible growth stage increased grain protein levels above when nitrogen was applied at early tillering or stem elongation. It is important to consider nitrogen timing if aiming for specific low or high grain protein levels in order to access grain protein price premiums.

Growth and yield data show that nitrogen fertiliser may substitute for nitrogen supplied from the soil however intensively cropped fields will require up to 240 kg N/ha to produce yields similar to those produced with 60–120 kg N/ha on medium fertility fields. 

Further information

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