Nitrogen timing trial

Background

There has been considerable studies undertaken on the timing of nitrogen in southern Australia under well drained, ideal, conditions. But there is very little information available on the optimum timing under waterlogged conditions. This nitrogen trial was designed to determine the optimum timing of nitrogen in waterlogged wheat. Nitrogen timing was related back to two key variables; crop growth stage and soil waterlogging. The latter was measured by depth of perched water table using piezometers.

What was done

The site selected at Berry's property on the corner of Wests Rd and Birchmore Rd was a poorly drained, severely waterlogged site. The duplex soil had high fertility with Colwell Phosphorus of 89mg/kg, Sulphur of 50mg/kg and Potassium of 294mg/kg. Piezometer data indicated that the site was waterlogged for approximately 40 days. Given the site received 645mm rainfall for 2011 (higher than the 500mm average) it could be considered wetter than normal. The trial was sown to Wyalkatchem wheat on the 20th of May at 90kg/ha plus 82kg/ha DAP. In-crop agronomy can be considered standard Kangaroo Island practice but with no post sowing nitrogen (N) applied, except as indicated in treatment descriptions in Table 1.

The trial was a completely randomised blocked design with 4 replicates. This means that each nitrogen treatment appeared 4 times in the trial, once in each of the four blocks. Each plot was 8m long by 3m wide.

Urea was used as a source of N and was applied at different rates and timings as per Table 1 below. Note that the timing is in days after sowing to enable easy comparison.

TABLE 1:- **treatments defined and timing in days from sowing**

Treatment	**Description**	**Timing (days after sowing)**
Control	Nil Urea applied	NA
Split application/trickle	100kg Urea applied in 3 even fractions at GS30, GS33 and ear emergence	69,90,111
Early tillering	100kg Urea applied at 5-7 leaf stage	33
Single GS 30	100kg Urea applied at the start of stem elongation	69
Double split	200kg Urea applied in 2 even fractions at GS 30 and ear emergence	69,111
Single GS33	100kg Urea applied during stem elongation	90
Single Start ear emerge	100kg Urea applied at start of ear emergence	103
Single ears emerged	100kg Urea applied after ear emergence	111
Single flowering	100kg Urea applied at flowering	122
Control 2	Second control will Nil Urea applied	NA

Results

Figure 1 shows the change in waterlogging during the growing season. From field observation, the site can be considered severely waterlogged when the water table is within 5cm of the soil surface. The crop was waterlogged from the start of tillering (30DAS) through to stem elongation (65DAS) and again at mid stem elongation from 85DAS for approximately one week.

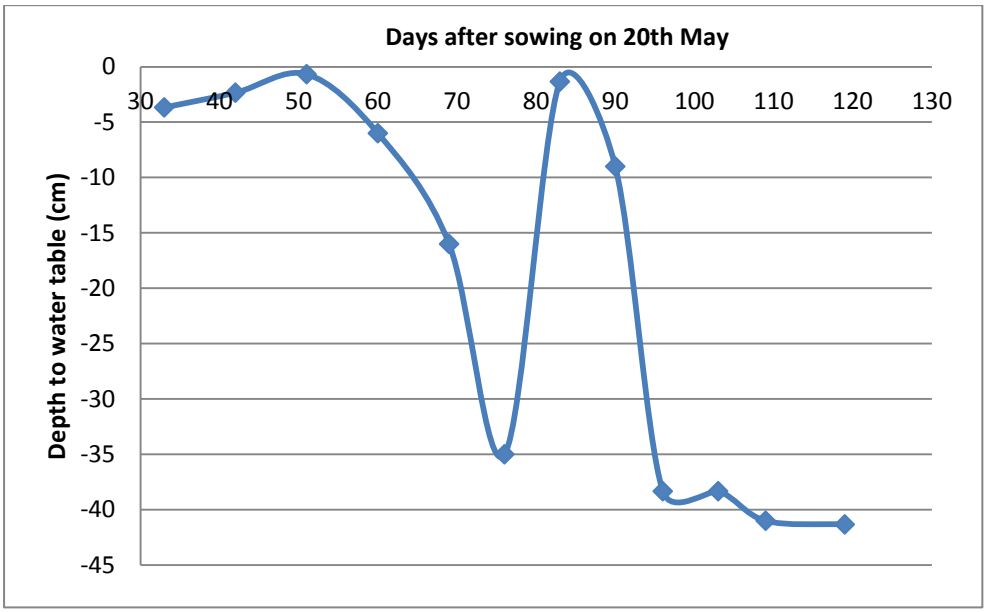

FIGURE 1: - **The change in water table depth during the growing season. The top of the horizontal axis (zero depth) can be imagined as the soil surface. Note that data was only collected starting 30 days after sowing. From 95DAS the trial was dry.**

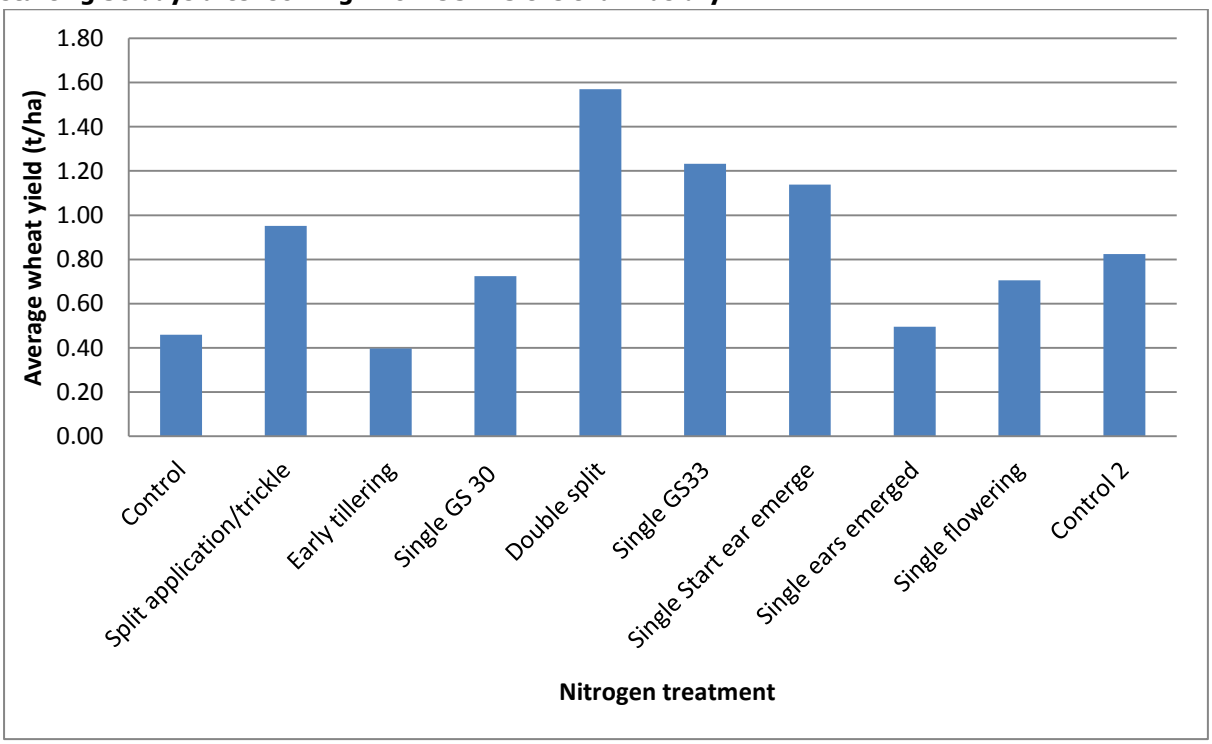

FIGURE 2: **- The effect of nitrogen treatment on grain yield for wheat under waterlogged conditions. LSD 95% equals 0.66 t/ha.**

Figure 2 above shows the impact of various timing and rates of nitrogen (N) on yield. Unfortunately, due to the high variation in the trial, the LSD 95% of 0.66 is high. As a result, using a 95% confidence interval, there are no significant differences. The fact that Control 2 is the same treatment as Control 1 but achieved twice the yield is a good indication of large variation in the results.

Whilst the differences are not statistically significant, the results suggest that the double split application had the highest yield. Assuming this was correct; comparing the double treatment group to the single treatment group in Table 2, there is 0.76t difference in yield. At $200/t this could mean $150 extra income per ha, easily justifying the $70 for the extra 100kg N applied. We must remember that we cannot be confident of this calculation due to the unreliability of the results, but it is definitely an area that warrants further investigation.

Table 2 below shows the impact of treatment groups on yield. Note some treatments qualify for more than one group. For example, the early tillering treatment would qualify for 'N applied early' group and 'N applied during waterlogging.' Some treatment groups may only be the average of only one treatment.

TABLE 2: **the impact of treatment groups on yield**

Treatment groups	**Average yield (t/ha)**
Control	0.64
All 100kg/ha N	0.81
Double N	1.57
N applied early	0.56
N applied late	0.78
N applied during waterlogging	0.82
N applied while not waterlogged	0.89

If we do a similar calculation comparing the control to the 100kg/ha single treatment group in Table 2, we get a very different result. The $70/ha of extra 100kg/ha N (control is zero kg N/ha) only increased the yield by 0.17t/ha not enough to justify the expense. The 'trickle 100kg/ha' and 'GS33 single 100kg/ha' treatments in Figure 1 performed better than the average over all timings for the 100kg/ha rate, seen in Table 2. Therefore it may be possible to economically justify 100kg/ha of N if it is applied at these timings. Again we need to remember that the results are not significant and just altering the control which we use (control 1 or control 2) varies the outcome of the comparison.

Whilst they are both around the recommended time of a single application of urea on drained soils (start stem elongation) the yield was higher for GS33 than the GS30 treatment. Note this is only indicative as it is not statistically significant. It is interesting to note that GS33 treatment was applied while soil was drying out while GS30 was applied under severe waterlogged conditions.

If we compare the average of N applied during non-waterlogged conditions and N applied during waterlogged conditions in Table 2 we only see a very minor increase under drained

conditions. Unfortunately, we are also effectively comparing late timings to early as generally the trial was waterlogged for early treatments and drained for late. In the absence of waterlogging we would expect less yield benefit of the later N treatments.

TABLE 3: - **The effect of nitrogen timing on grain protein**

Treatment	Protein (%)
Control	11
Split application/trickle	10.8
Early tillering	10.2
Single GS 30	9.9
Double split	10.6
Single GS33	10.2
Single Start ear emerge	10.3
Single ears emerged	10.6
Single flowering	12.6
Control 2	11.1

The protein data in Table 3 is a bulked average and hence is not replicated. Therefore, there is no possibility for statistical analysis. We must be careful about drawing conclusions from small differences. But it is interesting to note that the late application of N (single flowering treatment) resulted in the highest protein. This is intuitive as grain number and maximum yield is set at flowering and hence N applications at this time will only aid grain quality.

Further information contact

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Take home messages

- Results are complex and its difficult to separate the effect of waterlogging and crop development stage

Results not statistically significant but suggest:

- Double application of nitrogen increased the crop yield
- Potentially there is a benefit in applying nitrogen once waterlogging abating
- Quality increased with late application of nitrogen but yield did not increase.

Sponsors and contributors

- GRDC funding administered by AgKI
- Berry family for providing land and spraying trial
- Kangaroo Island Pure Grain for grain classification

Water on the surface of the Nitrogen trial, this was a common sight.

The green plot has had N applied, the other plots have not.