Improving Nitrogen Use Efficiency in the High Rainfall Zone of south western Victoria.

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Abstract

In the south west of Victoria, large grain yields have been achieved by broadcast nitrogen at stem elongation (Z31). However, due to the high annual rainfall of the region (600 mm) a high frequency of denitrification can reduce efficacy of nitrogen and in turn lower yields.

It is possible that mid-row banding nitrogen at sowing would reduce losses from denitrification and give better return on fertiliser investment. This trial showed in the 2018/19 season at Inverleigh, there was no advantage to mid-row band over broadcasting nitrogen at Z31 in a lower rainfall year (decile 1-2 year). To achieve a more conclusive result it would be beneficial to continue mid row banding research to gather data about the practise over several seasons to determine its long-term viability.

Keywords: Mid-row banding, urea, broadcast, nitrification inhibitor, controlled release fertiliser

Introduction

Nitrogen (N) fertiliser usage in Australia has experienced a gradual growth of by 14% per annum from 1990 to 2001, as farming systems have become more reliant on fertiliser derived N due to reduced legume pasture phases in broadacre cropping (Angus 2001). This trend has been particularly evident in the high rainfall zone (HRZ) of Victoria; and given the significant yield potential in such environments, high rates of N fertilisers are required (Zhang 2005). The most common form of N fertiliser used in Victoria is granular urea (46% nitrogen) due to price and availability. However, due to the variable nature of seasons combined with the risk of seed damage and in some cases haying off, typical industry practice involves application by broadcasting prior to or around stem elongation (Z31, Zadoks) which has been shown to result in similar grain yield to where N is applied at sowing (Fischer 1993). While applying N at Z31 better aligns with crop demand and has been shown to reduce N loss to the environment (Harris et al. 2016), it may be hindered by poor trafficability during wet winter conditions. Therefore, other options are needed to allow application of high rates of N (> 100 kg N/ha) at sowing without seed damage, reducing N losses and potentially slowing crop access to the N to avoid the risk of haying-off.

One alternative to broadcasting N during the season is the use of mid-row banding (MRB); where fertiliser is placed between every second row at 8-10 cm below the soil surface. Applying high rates of N in this way at sowing could reduce the need for mid-season fertiliser application (Angus et al. 2014), allowing a full season amount of fertiliser to be banded at sowing. Mid-row banding also ensures adequate seed-fertiliser separation to avoid fertiliser toxicity and associated reductions in crop establishment and may reduce the risk of ammonia volatilisation compared with surface application (Rochette et al. 2013). Furthermore, applying concentrated bands of fertilisers such as urea has been shown to alter the soil environment (increasing pH and altering microbial activity). The practice maintains N as ammonium (plant available) and allows a slow conversion to nitrate, potentially reducing loss of N due to denitrification or nitrate leaching as well as immobilisation. Thereby improving crop access to applied N and increasing nitrogen use efficiency (NUE). This paper outlines findings from a study undertaken during 2018 to test the effectiveness of mid-row banding at sowing in comparison to the industry standard of broadcasting urea at Z31 and whether the effects of fertiliser placement change with urea formulation (nitrification inhibitor or slow release formulation).

Method

In 2018, a field trial was established at Inverleigh to test the effect of mid-row banding urea at sowing with broadcast urea at Z31 across a range of rates and urea-based fertilisers. The trial was sown in a complete randomised block design with four replicates on 7 May 2018 using two passes. Mid-row banding was applied with the first pass followed by herbicides and then additional fertilizer (MAP 100 kg/ha) and seed (wheat cv. LRPB Trojan). All plots received mid-row cultivation to 8 cm to account for any effect of soil

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disruption across non-mid-row treatments. Weeds, pests and disease were all managed according to industry best practice.

Fertilisers used: Granular urea 46% nitrogen, ENTEC® (46% N, coated with 3,4-dimethylpyrazole DMPP) and Kingenta© 90-day controlled release urea (43% N, coated with a polymer that forms a direct barrier between the granule of urea and environmental conditions, nitrogen release is temperature and moisture dependent).

Nitrogen rates were calculated based on pre-season deep N soil testing, total mineral N 113 kg N to 90cm (Figure 1) and estimating the required N for a target yield (8 t/ha, to match Inverleigh NVT yield targets). Three N rates were included (62, 125 and 209 kg N/ha) to test for a range of yield potentials.

Soil mineral N (soil nitrate and ammonium) analysed at depth of 0-30cm, 30-60cm and 60-90cm pre- and in-season (5/06/2018) (Figure 1). Plots were mechanically harvested to gain plot grain yield, with grain subsamples taken on a replication basis to test for grain protein, test weight, screenings.

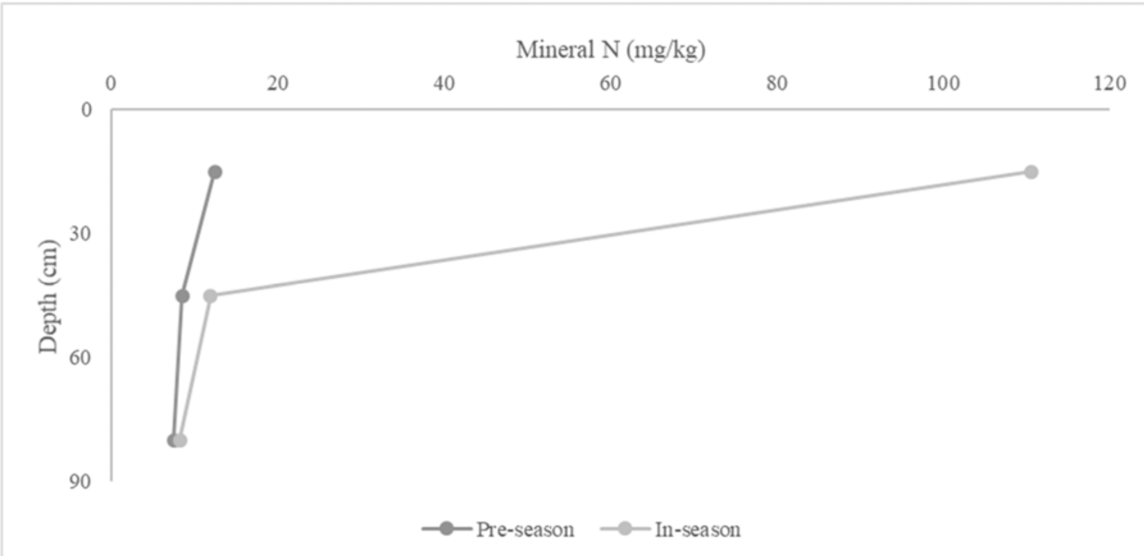

Figure 1. Soil mineral N (sum of nitrate and ammonium on Control – nil) to a depth of 90 cm at Inverleigh prior to sowing and on 5 June 2018 (single cores). Total mineral N to 90cm was 113 kg N/ha at sowing and 301 kg N/ha on 5 June.

Table 1. Details of the different treatments used in the mid-row banding trial, Inverleigh 2018/19.

Application	Product	Rate (kg N/ha)	Timing
Control – nil	Untreated control	Nil	Nil
Broadcast	ENTEC	62	Z31
Broadcast	ENTEC	125	Z31
Broadcast	Kingenta	62	Z31
Broadcast	Kingenta	125	Z31
Broadcast	Urea	62	Z31
Broadcast	Urea	125	Z31
Mid-row	ENTEC	62	Sowing
Mid-row	ENTEC	125	Sowing
Mid-row	Kingenta	62	Sowing
Mid-row	Kingenta	125	Sowing
Mid-row	Urea	62	Sowing
Mid-row	Urea	125	Sowing
Control – max	Urea	208	Z15, Z31 & Z50

Table 2. Growing season rainfall (mm) during the growing season at Inverleigh in 2018 and long-term average (1970 to 2018). Parentheses in 2018 data indicate seasons deciles based on long term average.

Date	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
2018 Rainfall (mm)	17	77	50	51	49	21	24	31	319 (1-2)
Average Rainfall (mm)	41	50	51	56	58	60	60	50	426 (5)

Results and Discussion

With a yield target of 8 t/ha based of average NVT wheat yields and available N at sowing (Figure 1), a response from applied N was expected. Spring rainfall (Table 2) and high result from the soil N test (Figure 1) reduced site responsiveness, which likely due to the fertiliser history.

There was a significant (P<0.05) N rate response to grain protein percentage (Table 3). In this situation, the applied N was likely absorbed during high plant demand but with low spring rainfall during the grain production phase, the N was most likely translocated into the grain which increased protein as observed by Wang (2003) and Cameron (2013).

Application method and fertiliser showed a no effect on grain yield, however there was an interaction between application method, N rate and product on grain protein. Product difference also were shown, the polymer coated Kingenta© had significantly lower protein when it was broadcast at the two rates (62 and 125 kg/ha) when compared to urea. ENTEC® performed better than urea when broadcasted at the higher rate of 125 kg/ha and was similar to 208 kg/ha of urea MRB.

As LRPB Trojan is graded as an APW wheat at its highest, the aim was to meet those requires for all nitrogen applied treatment. Protein (above 10.5%) and screenings (below 5%) both met the quality standards, however test weights for all treatments where below the required 76 kg/hL (Grain Corp 2018/19).

Screenings percentages are all with in accepted receival grade for Australian Premium White (5%) (Grain Corp 2018/19). This was not expected as a drier season and high grain protein often result in high screenings. Sub-grade test weights can be explained by late season rainfall delaying harvest and early maturity of the plots, this will have cause wrinkling of the grain (Yamazaki 1969).

Table 3. The effect of application method, product and rate of nitrogen (N) on grain yield, protein, test weight and screenings of wheat cv. LRPB Trojan at Inverleigh, 2018/19.

Application method	Product	N rate (kg/ha)	Grain Yield (t/ha)	Grain Protein (%) †	Test Weight (kg/hL)	Screenings (%)
Control – nil	Nil	Nil	6.8	9.8[a]	74.1	2.6
Broadcast	ENTEC	62	6.7	11.1[cde]	74.4	2.0
Broadcast	Kingenta	62	6.3	10.3[ab]	74.3	3.1
Broadcast	Urea	62	6.5	11.1[cde]	73.8	2.8
Broadcast	ENTEC	125	6.7	12.5[f]	73.4	1.9
Broadcast	Kingenta	125	6.7	10.4[abc]	72.7	3.0
Broadcast	Urea	125	6.6	11.5[e]	72.4	2.4
Mid-row	ENTEC	62	6.3	10.8[bcd]	73.9	2.0
Mid-row	Kingenta	62	6.8	10.6[bc]	74.6	2.4
Mid-row	Urea	62	6.5	11.0[cde]	75.2	1.9
Mid-row	ENTEC	125	6.5	11.5[de]	63.8	2.3
Mid-row	Kingenta	125	6.3	11.5[e]	74.0	1.8
Mid-row	Urea	125	6.6	11.5[e]	73.5	2.1
Control – max	Urea	208	6.1	12.9[f]	73.3	1.5
LSD (P<0.05)			NS*	0.7	NS*	NS*

†Values followed by the same letter do not significantly differ (P<0.05). *NS not significant.

Conclusions

Results from Inverleigh in 2018/19 season indicated limited effect of N application on grain yield. However N application increased grain protein and a significant interaction was observed between methods of application, fertiliser product and N rate. While urea broadcast and MRB gave similar protein (11% and 11.5%) results across both rates, ENTEC® was either on par or significantly higher. To achieve a more conclusive result, it would be beneficial to continue mid row banding research to gather data about the practise over a number of seasons to determine its long-term viability.

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