Improving nitrogen use efficiency through mid-row banding nitrogen

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Background

The issue of nitrogen use efficiency (NUE) has been identified as a critical constraint to crop production and sustainable farm practices in the Albany Port Zone. In the intensive farming systems of the HRZ, nitrogen fertilisers play a crucial role in crop production; however, the application of this is relatively inefficient. Research has shown that approximately 42% of the applied N is recovered, with the rest lost to volatilisation, leaching, runoff and denitrification. This can lead to increased acidification of soils, pollution of water ways and an increased carbon footprint. Nitrous oxide (N2O) is 298 times more polluting than carbon dioxide and is released into the atmosphere by denitrification. This is exacerbated in seasons where there has been severe waterlogging, and nitrates are rapidly denitrified by bacteria, and released into the atmosphere. Maximising your NUE is intrinsically linked to sustainability.

The recovery efficiency of a fertiliser application is often dictated by environmental conditions near the time of an application. A rainfall event can be crucial determining factor in N recovery rate, of top-dressed fertiliser, which exposes the fertiliser product to the environment.

NUE is often determined by a complex relationship between soil type, environmental conditions, application method, and the amount applied. However, a poor NUE can often boil down to an oversupply of N. This is often driven by two key factors: an over estimation of yield potential in a given season and an under estimation of the pooled N and existing N mineralisation potential which is driven by in season rainfall and soil organic carbon.

The time of peak mineralisation and peak N demand are unlikely to align, and the rate of mineralisation will not meet the crop's N demand in the sandy soils of our region. Thus, fertiliser will need to be applied to fill this gap. Split applications of fertiliser can help increase the NUE, by reducing losses through applying excess fertiliser, however applying many small applications, rather than a few larger applications at a time is both economically and opportunistically costly.

With Nitrogen intrinsically linked to biomass production and grain quality, it is an imperative that crops be provided with the adequate level of nutrition, in the most economically and environmentally sustainable way.

Banding fertiliser could provide the solution to this problem. By placing the fertiliser in the ground, the risk of losses via volatilisation and leaching due to environmental constraints such as prolonged dry periods can be reduced, improving the N recovery efficiency. Previous studies have found that banding fertiliser not only reduces N losses, but it also slows the rate of nitrate conversion and microbial tie up, allowing plants to access the N pools for longer periods in the critical growth stages.

Mid-row banding of fertilisers is a relatively new concept where the fertiliser is placed below the surface of every second interrow. Studies have shown that MRB consistently leads to increases in NUE over top-dressing. Stirlings to Coast Farmers conducted research into MRB of fertiliser during the 2020 season.

Project Aim

Our project aimed to address poor nitrogen use efficiency (NUE) in broadacre cropping systems in the high rainfall zone of WA.

We hypothesised that mid-row banding (MRB), applying nitrogen below the surface on every second inter-row, could improve NUE. Previous research in Victoria has shown that significant yield gains can be achieved by enhancing NUE efficiency through MRB, particularly when MRB was used to apply fertiliser in season.

Methodology

To test this hypothesis, SCF set up field trials to measure if MRB fertiliser could increase NUE and productivity, increasing sustainable farming practices in the HRZ. Two trials were carried out: a farm-scale demonstration and a small plot trial.

Small plot trial

The small plot trial aimed to assess and evaluate six methods in which fertiliser can be applied and compared the efficacy of different application methods. The treatments for this trial were:

Treatment 1: MRB 125kg/ha Urea at seeding & MRB 100L/ha of

Flexi N at tillering.

Treatment 2: MRB 125kg/ha Urea at seeding & Top-dressing 100L/ha of Flexi N at tillering.

Treatment 3: Top-dressing 125kg/ha Urea at seeding & MRB 100L/ha of Flexi N at tillering.

Treatment 4: Top-dressing 125kg/ha Urea at seeding & Top-dressing 100L/ha of Flexi N at tillering.

Treatment 5: Nil Urea at seeding, & MRB 100L/ha of Flexi N at tillering.

Treatment 6: Nil Urea & Topdressing 100L/ha of Flexi N at tillering.

Results

The small plot trial results indicated that in combination with topdressing (TD), MRB was the most effective management strategy to increase yield, irrespective of which order the treatments came in. The combination of both application methods resulted in the greatest NUE, and as an extension, is the most sustainable practice. Interestingly, the dual applications via mid-row banding resulted in a statistically significantly lower yield than the combination of MRB and TD. Furthermore, the order in which the application methods were applied did not affect the yield results: MRB at seeding and TD in season, performed the same as TD at seeding and MRB in-season.

This contrasts that of the results found in Victoria in 2016/17, which found that dual applications via MRB resulted in the greatest recovery efficiency. We speculate that there is an environmental reason for this contrast in results. The 2020 growing season in our region suffered a particularly dry start, which could have had an affect on the effectiveness of the MRB treatments, as the 2016 study in Victoria found that a rain event after banded fertiliser is applied reduced plant uptake, where if fertiliser was top-dressed this would increase plant uptake.

It should be noted that the fertiliser application method did not influence grain protein percentage. However, all treatments that received two fertiliser applications resulted in a significantly higher protein percentage than the single application plots. This indicates a critical mass of nitrogen is needed to achieve optimal protein content rather than the application method from which it is applied. This project demonstrated that although MRB can improve NUE, it does not improve grain protein accumulation.

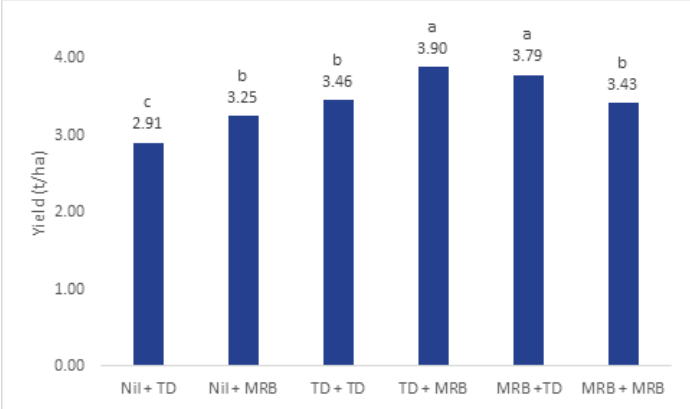

Figure 1. Average grain yields for 2020 at South Stirlings. Columns with different letters on top are significantly different from others.

Conclusions

Overall, these results indicate that MRB can be implemented in combination with topdressing fertiliser to improve NUE in the HRZ. This is encouraging for widespread adoption of the management practice, as a single application of MRB fertiliser at the time of seeding would be easier for growers to adopt with current technological capabilities than MRB at tillering.

More research needs to be conducted into MRB in-season to determine how environmental conditions affect N recovery rates and under what conditions optimal NUE can be achieved.

If farming is to become more sustainable then NUE will play a key role. Soils within the Albany Port Zone typically have a low pH, with growers in the region routinely liming soils. Soil acidification rates could be slowed by MRB nitrogen through reduced nitrification and leaching. By banding N enriched fertilisers, farmers can look to increase their NUE and reduce their inputs, both improving their carbon footprint and increasing their economic returns.

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