Fluid delivery systems and fungicides in wheat

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Funded By: SAGIT S614.
Project Title: Improving fertiliser efficiency and reducing disease impacts using fluid delivery systems,
Peer Review: Nigel Wilhelm (SARDI)
Key Words: *Fluid fertiliser, fungicides, wheat, Rhizoctonia, low rainfall*

Key Messages

- Phosphoric acid as a liquid fertiliser resulted in 13% and 8% higher yields in 2014 and 2015 respectively at Streaky Bay, and an 8% yield increase at Warramboo in 2016 when compared to the same rate of P delivered in granular fertilisers.
- Despite the yield increases at Streaky Bay and Warramboo the economics showed granular fertiliser had greater returns in $/ha compared to using phosphoric acid at 9 units of P.
- The guidelines for moving to the adoption of phosphoric acid as a P source exist in the Fluid Fertiliser Manual which adequately covers the principles, economics, recommendations and chemistry of adopting fluid delivery systems. The manual is available at www.fluidfertilisers.com.au.
- Knowing the responsiveness of a soil type to phosphoric acid is an important factor to consider before investing in a fluid delivery system. The responsive soil types are generally higher in calcium carbonate (greater than 25%). P source responses may also be driven by soil moisture conditions because in 2016, which had wetter seasonal conditions, phosphoric acid and granular P performed similarly in the same soil type at Streaky Bay.
- The adoption of fluid fertiliser systems to place fungicides in-furrow for rhizoctonia disease management is not recommended in this environment. The addition of fungicides showed small and variable yield advantages at Warramboo in 2014 and 2016 and Streaky Bay in 2016. Using fungicides in above average seasons the greatest yield benefit was only 0.22 t/ha with an in-furrow split application with granular phosphorus and trace elements. Including fungicides on wheat up front will increase input costs and risk over a large cropping program.
- Large scale demonstrations by growers across Eyre Peninsula with in-furrow fungicide applications at seeding did not reduce rhizoctonia or produce yield benefits over three seasons.

Background

The aim of this SAGIT-funded project was to build on previous research by updating knowledge of the benefits, including disease control and nutrition, of fluid delivery systems. Fluid systems have the potential to increase production through efficient delivery of micro and macro nutrients, reduced cost of trace element delivery and increased control of cereal, root and leaf diseases using new fungicide products.

Historically, fungicidal control of Rhizoctonia, which can infect all of the major crops grown in southern Australia, has generally been poor, but fluid systems are a new option for delivery of fungicides, which potentially may improve disease control and increase production. Trials were undertaken over three years to assess the benefits of fluid delivery of nutrients and fungicides, under various application strategies, to wheat grown in two upper Eyre Peninsula environments.

The individual wheat trials in each season are reported in Eyre Peninsula Farming Systems Summary 2016, *Fluid delivery systems and fungicides in wheat* p 71, Eyre Peninsula Farming Systems Summary 2015, *Fluid delivery systems and fungicides in wheat* p 114 and Eyre Peninsula Farming Systems Summary 2014, *Fluid delivery systems and fungicides in wheat at Warramboo and Streaky Bay* p 98.

In the 2014, 2015 and 2016 seasons, three replicated trials were established (total of 9 trials), at Warramboo on a red sandy soil and two at Streaky Bay on a grey calcareous sand. Both sites had nutrition delivery treatments and fungicide application strategies. The fluid fertiliser delivery system placed fluid fertiliser approximately 3 cm below the seed at an output rate of 100 L/ha. The fluid system could also split the fluids to deliver the fungicide both below the seed at approximately 3 cm, and in the seeder furrow behind the press wheel in a band approximately 1 cm in width.

About the trial

The control was 60 kg/ha of Mace wheat with 50 kg/ha of 18:20:0:0 (DAP). All phosphorus treatments were applied to the same rate of 9 kg/ha of phosphorus (P) and balanced with urea or UAN to 10 kg/ha of nitrogen (N). Manganese (Mn) was selected as the main focus trace element and a DAP fertiliser dry blend with Mn @ 1.5 kg/ha was used. Phosphoric acid and granular urea, or ammonium poly phosphate (APP) and urea ammonium nitrate (UAN) were used as fluid fertiliser products to compare with granular fertilisers. Manganese sulphate was dissolved with the standard rate being 1.5 kg Mn/ha and 3 kg/ha as a high rate. 1 kg/ha Zn, as zinc sulphate and 0.2 kg/ha Cu as copper sulphate were dissolved in the standard rates of trace elements, which were also delivered as foliar applications at 4-5 leaf stage. The extra nitrogen at seeding treatment was applied as 40 kg/ha of granular urea.

The fungicides azoxystrobin + metalaxyl-M (Uniform), penflufen (EverGol Prime, and new formulation of EverGol Prime for fluid delivery in 2016) and sedaxane (Vibrance seed dressing) were assessed for Rhizoctonia disease suppression at different rates and in split applications. Triadimenol and flutriafol were also applied on fertiliser as treatments.

PreDictaB disease inoculum levels (RDTS), soil nutrition, soil moisture, plant establishment, Rhizoctonia seminal root score, Rhizoctonia crown root score, grain yield and quality were measured during each season. Rhizoctonia infection on seminal roots and crown roots was assessed using the root scoring method described by McDonald and Rovira (1983) approximately six to eight weeks after seeding. Crown roots per plant were also counted on these samples with the number of roots infected with Rhizoctonia used to calculate % crown root infection. Trials were harvested and grain quality analysed.

Results & Discussion

The trial sites selected were on the same property but in different paddocks each season.

Soil type

Both soils have alkaline pH and reasonable soil phosphorus levels. The main difference between these soil types based from previous soil analyses is the calcium carbonate content of around 55- 80% to 60 cm at Streaky Bay and Piednippie compared to 0-25% calcium carbonate content on the red sandy loams of Central Eyre Peninsula. Mineral nitrogen level was much higher at Streaky Bay than Warramboo as is the PBI, especially in the 0-10 cm zone. Both of the soils chosen had been phosphorus responsive to phosphoric acid in previous research.

Disease levels - Rhizoctonia solani

Rhizoctonia was the main disease inoculum present with most other diseases at low levels, except the Warramboo site in 2014 which also had a high Take-all disease risk level. The 2016 trial at Warramboo had very low risk of rhizoctonia disease level which was likely due to the pasture phase in 2015, which reduced inoculum levels compared with a wheat phase, however some Rhizoctonia patches were visible in the trial area early in the season. Overall the grey calcareous soil at Streaky Bay had higher Rhizoctonia disease risk level in each season than Warramboo.

Seasonal conditions, plant establishment and early dry matter

Overall plant establishment showed no differences over the three seasons due to the fluid nutrition. The only lower plant establishment was in 2015 in good seeding conditions at Warramboo where the in-furrow fungicide treatment and a fertiliser applied fungicide treatment resulted in poorer plant establishment. In 2015 in Streaky Bay the overall plant establishment was poorer than Warramboo due to the dry seeding conditions but wasn't affected by treatments applied.

Disease infection - Rhizoctonia solani

In 2014 neither of the fungicide trials at Warramboo or Streaky Bay had differences in Rhizoctonia root assessment for the seminal nor crown roots taken at eight weeks. The average seminal root infection was 3.24 (0-5 score) at Streaky Bay and 81% average crown root infection, with Warramboo having 2.75 average seminal root infection, and lower average crown root infection of 44%.

In 2015 the fungicide treatments at Warramboo had Rhizoctonia infection on both seminal and crown roots however there were no differences between fungicide treatments in the rhizoctonia root assessment taken at eight weeks, with 3.11 average seminal root infection, and average crown root infection of 69%. Rhizoctonia patches were present in the Streaky Bay trial early in the 2015 season. The low soil moisture resulted in stressed plants and limited early plant growth. There were no differences due to the fungicides applied in the root assessments with the average seminal root infection being 3.09 (0-5 score) and 74% average crown root infection.

The 2016 Streaky Bay fungicide trial had more even growth earlier in the season than the nutrition trial, but Rhizoctonia patches were still present. The additional nitrogen treatments were visually better in the fungicide trial early in the season. There were no differences in late season dry matter or Rhizoctonia crown root infection (76%) between the fungicide treatments in 2016 but the EverGol Prime (new formulation) with extra nitrogen had lower Rhizoctonia seminal root infection scores than the control treatment in 2016. At Warramboo, in drier conditions, phosphoric acid + trace element + fungicide (Uniform and new formulation of penflufen) split + extra nitrogen treatments had lower Rhizoctonia seminal root infection than the control. There were no differences in crown root infection (average 56%).

Grain Yield and Quality

Overall there was a 0.11 t/ha (8% from 1.25 t/ha using granular DAP to 1.36 t/ha with phosphoric acid in 2015) yield increase and 0.13 t/ha yield increase (13% in 2014) using phosphoric acid in Streaky Bay in drier seasons (Cook et al, 2015). In 2016 there was no benefit to using phosphoric acid at Streaky Bay. In previous seasons there has been no fertiliser response at Warramboo; however there was a response to phosphorus source in 2016 of 0.17 t/ha yield increase or 8% from 2.11 t/ha using granular DAP to 2.28 t/ha using phosphoric acid.

Input costs were lowest for the control ($148/ha) so all other options would result in higher costs over a whole cropping program. Phosphoric acid fertiliser showed yield increases at Streaky Bay in 2014 and 2015, however the economics showed granular fertiliser still had greater returns in $/ha compared to using phosphoric acid (see 2016 article for further detail). At Warramboo in 2016 using phosphoric acid showed a positive economic return over granular fertiliser.

The gross margins in 2014 and 2015 at Warramboo showed that the addition of a balanced trace element mix for an extra $4/ha over the control provided the best return over these seasons. The 2016 gross margins showed the difference between applying a fungicide compared to the control but the increase in the input costs resulted in higher cost risk over a whole cropping program. The results in the 2016 season have confirmed that soil type, and also soil moisture conditions, influence the response to phosphorus source.

Mixing fluid fertilisers

The chemistry of mixing fluids and the basic products have not changed; therefore, the Fluid Fertiliser Manual is still an excellent information source. The Fluid Fertiliser Manual provides a comprehensive description of fluid fertilisers, mixing fertilisers, application technologies and includes a simple economic calculator for growers to compare costs and responses of fertiliser types. It also allows an economic analysis of conversion costs to be calculated. The manual is available at www.fluidfertilisers.com.au.
However many of the products, including those for fungicide management in current farming systems, have changed so doing small product test mixing in jars is recommended when using new mixes or different product sources, as they may have different concentrations or compatibility and it is much easier to detect this early (in a jar) than having to clean tanks or fluid lines.

Implications for commercial practice

Over the three seasons of the fluid delivery trials on upper Eyre Peninsula the trial results at Streaky Bay in 2014 and 2015 showed improvements in grain yield through using a fluid form of phosphorous (phosphoric acid) over a granular product on the highly calcareous sandy loam soils. This yield response was 0.11 t/ha (8% from 1.25 t/ha using granular DAP to 1.36 t/ha in 2015) and 0.13 t/ha yield increase (13% in 2014). However in 2016 at Streaky Bay in a wetter season the phosphorus source showed a yield response. Yield improvements to the fluid form of phosphorous (phosphoric acid) were not measured on the red sandy soil at Warramboo in either 2014 or 2015, however in a drier season in 2016 phosphorus responses to phosphoric acid of 8% occurred.

Previous research has shown that in drier soil conditions the movement of phosphorus via soil water to the plant roots is restricted. Fluid fertilisers are able to diffuse away from the point of application in lower soil moisture conditions and are less likely to be fixed by calcium in soils with high levels of calcium carbonate (Holloway *et al*, 2002, Lombi *et al*, 2004). Knowing whether the soil type is responsive is essential before changing to a fluid fertiliser system, as phosphorus and soil moisture conditions play a role in the effectiveness of fluid phosphorous fertilisers as opposed to granular phosphorus fertilisers.

The addition of extra starter nitrogen (40 kg/ha at seeding as urea in some treatments in 2016) has also increased yield responses indicating that despite high initial soil nitrogen levels in these soils the plants may have benefited from the addition of nitrogen early.

Rhizoctonia continues to be the main cereal disease impacting on yields in the upper Eyre Peninsula environment. The soil types, often high disease inoculum levels, low soil moisture levels and early nutrient limitations impact on the ability of the plant to grow away from the disease. The seminal root scores and crown root infection levels were still high and not different to the controls when assessed at six to eight weeks after seeding despite the application of fungicide and visually appearing slightly more even in growth.

Treatments had little influence on plant establishment in this environment. The addition of fungicides showed small and variable yield advantages in these farming systems, at Warramboo in 2014 and 2016 and Streaky Bay in 2016. Using granular phosphorus and a trace element mix with fungicide showed the greatest benefit, and was 0.22 t/ha with a split application compared to other research which achieved up to 0.49 t/ha yield increases in wheat with split applications of fungicides (McKay et al, 2014). The research conducted in other regions also showed the yield response to fungicides was dependant on favourable spring conditions for grain filling.

The cost of including fungicides will increase input costs ($4-$25/ha) significantly over a whole cropping program, and even if high disease risk paddocks were targeted for use, the yield responses in these environments appear highly variable. It may be other factors in the Eyre Peninsula environment, either higher initial rhizoctonia inoculum levels especially in the grey calcareous soils, poorer plant nutrition and/or sharper spring conditions are limiting the response to fungicides. The gross margins in 2014 and 2015 at Warramboo show the addition of a balanced trace element mix for an extra $4/ha over the control and show the best return over these seasons. In 2016 the addition of fungicides to phosphoric acid and extra starter nitrogen at seeding as urea provided the greatest yield responses, however further validation over different seasons is recommended.

The most reliable method in this environment to reduce rhizoctonia inoculum and disease levels is still to include a break crop rotation before a cereal crop (Gupta, *et al*, 2013). All current information, including the increased input costs of including a fungicide, should be taken into account when formulating a management plan to control rhizoctonia in high risk situations.

The Fluid Fertiliser Manual still provides a comprehensive description of fluid fertilisers, mixing fertilisers, application technologies and includes a simple economic calculator for growers to compare costs and responses of fertiliser types. The manual is available at www.fluidfertilisers.com.au.

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Acknowledgements

Thank you to Darren Sampson and Luke Kelsh and families for supporting research by having trials on their properties. Thanks to Syngenta and Bayer for supplying fungicide products for the trial. The trial was funded by SAGIT Improving fertiliser efficiency and reducing disease impacts using fluid delivery systems, S614.