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Improving fertiliser efficiency and reducing disease impacts using fluid delivery systems.

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PROJECT REPORT

Executive Summary

Fluid delivery systems can be used in current farming systems for: the application of micronutrient solutions in-furrow at seeding which will reduce spraying requirements and mixing with in-season herbicides; the application of liquid P fertilisers gaining yield benefits from phosphoric acid fertilisers in responsive grey and red calcareous soil types; in-furrow applications of newer fungicide products for rhizoctonia management to improve root health and grain yield; and blackleg control in canola.

Three years of research trials were undertaken on Eyre Peninsula (EP) to assess the potential of fluid nutrient delivery systems, targeting the nutrients of phosphorus (P) and trace elements, Manganese (Mn), Zinc (Zn) and Copper (Cu). The disease control strategies targeted for EP were the fluid delivery of newer fungicides for rhizoctonia management in wheat and Blackleg in canola, compared to other application strategies. The key outcomes and guidelines from the research were:

- On responsive soil types on upper EP, 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, compared to the same rate of P delivered in granular fertilisers. However despite the yield increases at Streaky Bay in 2014 and 2015 the economics showed granular fertiliser had greater returns in $/ha compared to using phosphoric acid. At Warramboo in 2016 using phosphoric acid did show a positive economic return over granular fertiliser.
- 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. 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.
- When compared to foliar application or coated fertilisers, the trace element response of fluid delivery systems showed no advantage, as the trial sites did not show nutrient deficiencies, other than the 2014 Streaky Bay nutrition trial site which was slightly Zn deficient.
- The adoption of fluid fertiliser systems to place fungicides in-furrow for rhizoctonia disease management would not be 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. This is lower than the benefits achieved in other regions where yield increases of up to 0.49 t/ha in

wheat with split applications of fungicides were achieved. 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.
- In canola trials at Wangary, the application method of the fungicides for Blackleg management, either as seed treatments or in-furrow, did not increase canola yields in 2015 or 2016. Intake (on fertiliser) and Jockey (on seed) which is current standard practice, lowered Blackleg stem infection, and in 2014 this practice also increased grain yield. This remains the recommended practice for Blackleg management, however newer fungicide products were only released and tested in one season so may need further evaluation.
- The adoption of fluid fertiliser systems will depend on growers' soil types for phosphorus responses, the existence of trace element deficiencies and timing of application (in-furrow at seeding or in-crop) and machinery or machinery upgrades.

Project Objectives

Key aim: To provide guidelines to farmers on the best options for fluid delivery systems at seeding to increase crop yields and to decrease the impact of crop diseases in current farming systems across southern cropping regions.

This will be achieved by:
- Research trials to update the benefits of fluid delivery systems for nutrients and disease control options.
- Determining the economic returns of additions to the system over current fertiliser and disease control strategies.
- Providing farmer support (5 farmers annually) to monitor paddock demonstration strips to evaluate economic benefits of changes in products within fluid delivery systems (2014 funding from Community Landcare Grant).
- Providing guidelines and extension packages for farmers to adopt fluid nutrient and fungicide packages where appropriate.

Overall Performance

The research trials were successfully undertaken over three seasons to measure the benefits of fluid delivery systems and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. Two wheat trials were established, located at Warramboo (D Sampson) on red sand and Streaky Bay (L Kelsh) on grey calcareous sand, and a canola trial was located at Coulta (B Morgan) on shallow loamy clay.

The research trial outcomes show the benefits for adoption of fluid fertiliser systems to deliver P on responsive soil types. The existing Fluid Fertiliser Manual provides the principles and chemistry of fluid delivery systems. The current research provided more evidence about when it is worth considering the adoption of fluid delivery systems.

Extension activities including articles, field days and sticky beak days have been used to deliver these messages. Annual support was provided to 5 farmers to monitor paddock demonstration strips for evaluation of potential benefits in plant growth, root health, grain yield or quality following changes in products or application methods using fluid delivery systems. The farmer demonstrations trialled many different mixes including fungicide only mixes, fungicide and trace element mixes, soil wetters, trace elements and biological products. The farmer demonstrations showed little improvement in disease management or yield benefit in different regions of upper EP from liquid based products applied into the soil at seeding. Personnel who participated in the research project were Amanda Cook, Research Officer (In- Kind after 2014), Ian Richter, Agricultural Officer 0.3-0.4 FTE and casual labour. Amanda Cook changed research roles at the Minnipa Agricultural Centre in September 2014 undertaking the Senior Research Officer position in the GRDC Stubble Initiative and Weed Management Strategies for EP. Amanda has continued to manage project S614 to ensure the KPI's are delivered, with casual labour being employed to assist. Due to the changes in personnel roles, the original budget was underspent in salaries. Co-operators: Trials: Darren Sampson - Warramboo, Luke Kelsh – Streaky Bay, Bruce Morgan – Wangary, Trevor Gilmore – Streaky Bay. Farmer demonstrations (five per season): Graeme and Heather Baldock - Buckleboo, Andrew and Jenny Polkinghorne - Lock, Matt and Amanda Price – Cleve, Peter Kuhlman – Mudamuckla, Simon and Tania Patterson – Piednippie, Darren, Georgia and Carolyn Mudge – Miltaburra, Bruce and Kathy Heddle – Minnipa, Phil and Jan Wheaton – Streaky Bay.

Key Performance Indicators (KPI)

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
Year 1 (2014) Identify two trial sites (upper and lower EP) and farmer co-operators (three undertaken in 2014)	Yes Three trials were established in 2014 to measure the benefits of fluid delivery systems and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. Two wheat trials were established, located at Warramboo (D Sampson) on red sand and Streaky Bay (L Kelsh) on grey calcareous sand, and a canola trial was located at Coulta (B Morgan) on shallow loamy clay.	Completed April 2014

	In addition to the research trials, the project supported five farmers across Eyre Peninsula (EP) to validate changes/or responses to fluid delivery systems. In 2014 the five farm businesses involved in the demonstrations were; Graeme and Heather Baldock - Buckleboo, Andrew and Jenny Polkinghorne - Lock, Matt and Amanda Price – Cleve, Pete Kuhlman – Mudamuckla and Simon and Tania Patterson – Piednippie. Funding was secured from January 2014-15 for this by a Caring for Our Country Community Landcare grant (CLG-1205649-434). For further information and details on research trials and demonstrations see Appendix 1.	
Year 1 (2014) Devise and implement trial program to evaluate TE delivery and fungicides in current farming systems	Yes The trial included nutrition delivery treatments and fungicide application strategies. See Appendix 1 for treatments, trial details and results.	Completed July 2014
Year 1 (2014) Monitoring trials and results collated, analysed, published and presented to EP farmers annually	Yes 2014 trial results collated and analysed, and published in the Eyre Peninsula Farming Systems Summary 2014 in March 2015. The results were presented to EP farmers at farmer meetings on 16-20 March 2015.	Completed March 2015
Year 1 (2014) Monitor, collate and extend information from 5 farmer paddock demonstrations	Yes 2014 farmer demonstrations collated and analysed, and published in the Eyre Peninsula Farming Systems Summary 2014. The results were presented at farmer meetings on 16-20 March 2015.	Completed March 2015
Year 2 (2015) Identify two trial sites (upper and lower EP) and farmer co-operators	Yes Four trials were established in 2015 to measure the benefits of fluid delivery systems and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. Two wheat trials were established, located at Warramboo (D Sampson) on red sand and Streaky Bay (L Kelsh) on grey	Completed April 2015

	calcareous sand. The canola trial was split with the Blackleg trial located at Coulta (B Morgan) on shallow loamy clay and the nutrition trial located at Farm Beach (not harvested or reported). In addition to the research trials, the project supported six farmers across Eyre Peninsula (EP) to validate changes/or responses to fluid delivery systems. In 2015 the five farm businesses involved in the demonstrations were; Graeme and Heather Baldock - Buckleboo, Andrew and Jenny Polkinghorne - Lock, Matt and Amanda Price – Cleve, Peter Kuhlmann – Mudamuckla, Darren, Georgia and Carolyn Mudge - Miltaburra and Bruce and Kathy Heddle - Minnipa. For further information and details on 2015 research trials and demonstrations see Appendix 1 and 2.	
Year 2 (2015) Devise and implement trial program to evaluate TE delivery and fungicides in current farming systems	Yes The trial included nutrition delivery treatments and fungicide application strategies. See Appendix 1 for treatments, trial details and results.	Completed July 2015
Year 2 (2015) Monitoring trials and results collated, analysed, published and presented to EP and other low rainfall farmers annually	Yes 2015 trial results have been collated, analysed and published in the Eyre Peninsula Farming Systems Summary 2015 in March 2016. The article is available on the EPARF website and available to all farmers via the GRDC Online farm trial data base which links to the article and information published in the Eyre Peninsula Farming Systems Summary.	March 2016 Completed
Year 2 (2015) Monitor, collate and extend information from 5 farmer paddock demonstrations	Yes 2015 farmer demonstrations have been collated and analysed. The results were presented at farmer meetings on 10-18 March 2016.	March 2016 Completed

Year 3 (2016) Identify two trial sites (upper and lower EP) and farmer co-operators	Yes Two wheat trials were established, located at Warramboo (D Sampson) on red sand and Streaky Bay (L Kelsh) on grey calcareous sand. The canola Blackleg trial was located at Coulta (B Morgan) and the nutrition trial located at Streaky Bay (T Gilmores) (poor establishment due to wind damage, not reported). In addition to the research trials, the project supported five farmers across Eyre Peninsula (EP) to validate changes/or responses to fluid delivery systems. In 2016 the five farm businesses involved in the demonstrations were; Graeme and Heather Baldock - Buckleboo, Andrew and Jenny Polkinghorne - Lock, Phil and Jan Wheaton – Streaky Bay, Darren, Georgia and Carolyn Mudge - Miltaburra. For further information and details on 2016 research trials and demonstrations see Appendix 1 and 2. Total – Delivered 15 trials and supported sixteen farmer demonstrations by monitoring the broad acre treatments over 3 seasons of the project.	Completed April 2016
Year 3 (2016) Devise and implement trial program to evaluate TE delivery and fungicides in current farming systems	Yes The trial included nutrition delivery treatments and fungicide application strategies. See Appendix 1 for 2016 treatments, trial details and results**.**	Completed July 2016
Year 3 (2016) Monitoring trials and results collated, analysed, published and presented to EP farmers annually	Yes 2016 trial results have been collated, analysed and published in the Eyre Peninsula Farming Systems Summary 2016 in March 2017. The article is available on the EPARF website and available to all farmers via the GRDC Online farm trial data base which links to the article and information published in the Eyre Peninsula Farming Systems Summary. Youtube video recorded with SAGIT (Bridget Penna).	Completed March 2017

	"Trial gauges success of fertiliser delivery mode - Amanda Cook EP" https://www.youtube.com/watch?v=LlzQ8mMitTk	
Year 3 (2016) Monitor, collate and extend information from 5 farmer paddock demonstrations	Yes Final summary of the farmer demonstrations will be published in the 2018 in the Eyre Peninsula Farming Systems Summary.	March 2017 and pending March 2018
Year 3 (2016) Economic assessment and KASAP survey completed	Economic assessment completed May 2017. See Appendix 1 (Tables 4 and 5) for assumptions and results. KASA survey conducted August 2017, 27 respondents. This project influenced 26% of respondents in fluid delivery system decision making process (whether to adopt or not). Full report available in Appendix 3.	Completed August 2017
Year 3 (2016) Final Report	Yes Final Report Submitted	Completed August 2017

Technical Information

Wheat Trials 2014-2016

In 2014, 2015 and 2016 three replicated trials were established (total of 9 trials), at Warramboo on a red sandy soil and two replicated trials (total of 6 trials) 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 an approximate 1 cm band width.

The control treatment was 60 kg/ha of Mace wheat with 50 kg/ha of 18:20:0:0 (Di-Ammonium Phosphate - DAP). All phosphorus treatments were applied at the same rate of 9 units of phosphorus (P) and balanced with urea or UAN at 10 units of nitrogen (N). Manganese (Mn) was selected as the main focus trace element, with zinc (Zn) and copper (Cu) also included in the trace element mix. 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. Triadimefon and flutriafol were also applied on fertiliser as treatments.

PreDictaB disease inoculum levels, soil nutrition, soil moisture, plant establishment, rhizoctonia seminal root score, rhizoctonia crown root score, green leaf area index, 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 per cent crown root infection. Trials were harvested, generally in November, and grain quality analysed. Data were analysed using Analysis of Variance in GENSTAT version 16.

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 (Appendix 1 Table 2), 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 in the trials over the three seasons due to the fluid nutrition treatments. 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. See Appendix 1 for more detail on individual seasonal conditions.

The **2014** season had adequate soil moisture and early seeding in most areas, allowing the plants to grow through the impact of rhizoctonia root infection, especially at the Warramboo site. At Streaky Bay drier conditions at seeding with high inoculum level resulted in rhizoctonia patches being present. At Streaky Bay there were differences in the early dry matter in the nutrition treatment on the grey calcareous soil with most phosphoric acid with granular urea treatments having better early growth. The phosphoric acid and 3 kg/ha manganese sulphate as liquid and granular urea had significantly higher growth than the control. The tissue test taken at mid tillering showed some zinc deficiency at this site, with the trace element treatments having adequate levels.

In a poor season in **2015** at Streaky Bay the trial was very uneven and had patchy growth due to moisture stress early, lower germination as well as rhizoctonia disease expression. There were no differences at Warramboo in dry matter in fungicide and nutrition treatments in 2015.

In **2016** at Streaky Bay plant establishment in ideal seeding conditions had no difference between treatments. Rhizoctonia patches were visible in the Streaky Bay trial early in the season, however disease symptoms were much lower than in previous years, as soil moisture stress was low and early nutrition and plant growth was not as limited. The trial at Warramboo was sown later due to low soil moisture, but had good plant establishment, and no differences in plant establishment due to treatments applied at this site.

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 significant differences between the fungicide treatments imposed in the rhizoctonia root assessment taken at eight weeks, with 3.11 average seminal root infection and average crown root infection of 69%. The application of fungicides in furrow did not perform better than fertiliser application or seed dressing at this site.

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%) in the fungicide treatments in 2016 and the EverGol Prime (new formulation) with extra nitrogen also 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%).

Late Dry Matter, Grain Yield and Quality
In **2014** at Streaky Bay the nutrition trial showed a 0.13 t/ha yield increase over 18:20:0:0 using phosphoric acid as the phosphorus source. The tissue tests taken at mid tillering indicated zinc deficiency in some treatments at Streaky Bay, but it was corrected with the trace element treatment. Manganese deficiency was not detected at this site in tissue tests, despite the treatments with added manganese having better early growth. There were no significant differences in fungicide treatments, application method or rates.

At the Warramboo site in 2014 there were no ‘stand out’ treatments during the season, however the urea only treatment looked poor all season. There were no differences at Warramboo in the nutrition trial in dry matter or yield. At Warramboo in 2014 in the fungicide trial there were differences in late dry matter and grain yield with three fungicide treatments plus trace elements having higher dry matter and yield. The split application of fungicides in furrow did not perform better than fungicide in furrow below the seed, seed dressing or fertiliser application at this site.

In **2015** at Streaky Bay the phosphoric acid treatments had visually better early growth and were the highest yielding. There were no treatments which were visually better in the fungicide trial during the season. There were no differences in early and late dry matter or yield in the fungicide treatments in 2015, despite reasonable levels of rhizoctonia seminal and crown root infection.

There were no differences at Warramboo in dry matter or grain yield in fungicide and nutrition treatments, with treatments averaging 3.0 t/ha (Figure 1). Grain quality showed no differences. The trace element treatments or manganese treatments did not improve yield at either site in 2015.

In **2016** at Streaky Bay in a good season there were no differences in early or late dry matter or yield attributable to the nutrition treatments. In 2016 at Warramboo only the phosphoric acid +with trace element +, fungicide (Uniform) split +and extra nitrogen treatment had higher late dry matter than the control (Appendix 1 Table 4). The first five treatments in Table 5 (Appendix 1) had higher grain yields than the control and all of these had phosphoric acid as the base fertiliser.

Over all seasons there were no differences detected in grain quality due to the treatments imposed.

In 2014 and 2015 there was a 0.11 t/ha (8% from 1.25 t/ha using granular DAP to 1.36 t/ha 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 was no fertiliser response at Warramboo; however there was a response to phosphorus source in 2016, in a drier season 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.

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 and 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.

Economics

The input costs of the treatments (Appendix 1 - Table 4) shows that the control is the lowest cost option ($148/ha) and all other treatments have higher costs, resulting in higher cost risk 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 (Table 4). At Warramboo in 2016 using phosphoric acid did show a positive economic return over granular fertiliser.

In 2014 the soil type and season at Warramboo showed little yield response to phosphorus or alternative phosphorus sources, highlighting the need for a responsive soil type before changing to a fluid fertiliser strategy for phosphorus.

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 (Appendix 1 - Table 5) show 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.

Canola Trials 2014-2016

In each season the base fertiliser was 100 kg/ha of DAP (18:20:0:0) with additional in-furrow fungicides or trace elements delivered as fluids for treatments. The trace element mix was 1.5 kg/ha of Mn, 1 kg/ha Zn and 0.2 kg/ha Cu delivered as sulphates at a water rate of 100 L/ha. The fluid macro fertiliser treatments were equivalent to 100 kg/ha of 18:20:0:0 as phosphoric acid and granular urea banded below the canola seed variety Pioneer 45Y86 (CL). Trace elements were also delivered as foliar applications at 4-5 leaf stage, and also at a half rate.

The fungicides evaluated for blackleg disease control were Jockey and Intake in all seasons, and new products Aviator and Prosaro in 2016 only. Application methods of fungicides were also assessed, either in-furrow liquids, Jockey as a seed dressing or Intake on fertiliser. In 2016 foliar Aviator and Prosaro were also applied at 400 ml/ha and 550 ml/ha respectively at the 4 leaf stage.

Plant establishment, blackleg infection and grain yield were measured during the season. Blackleg infection was scored by assessing 20 stems per plot, cut at the base, in mid-November. Most in-crop operations such as chemical weed control, in crop applications of urea and insect control were applied broad acre by the farmer as required. Data analysis was undertaken using Analysis of Variance in GENSTAT version 16.

Canola nutrition – Coulta 2014

There were no differences in plant establishment. In 2014 no treatments performed better than the control for early dry matter, yield or grain quality (Appendix 1 - Table 6). Plant tissue tests (youngest leaf) were taken at late cabbage stage, and the results showed no trace element deficiencies.

The average yield of the different fertiliser types, granular or fluid; APP and UAN, phosphoric acid, granular DAP or urea only (Appendix 1 - Table 7) showed no differences.

2014 was the only year in which reliable nutrition data was achieved. In 2015 the nutrition trial at Farm Beach was not harvested as poor establishment, a very dry finish and extensive bird damage near maturity did not allow for fair comparisons between the treatments. In 2016 the nutrition trial site located at Piednippie had poor establishment, and despite re-sowing in early June did not establish due to wind damage. No data was collected from this site.

Fungicides for Blackleg - Coulta 2014 & 2015, Wangary 2016

In 2014 the treatment with both fungicides applied, Intake in furrow and Jockey seed dressing, increased yield over the nil treatment (Appendix 1 - Table 8), which is supported by previous research in this region. However their effect on blackleg were not as clear – there were no differences in the blackleg disease levels between any treatments in the trial. There were also no differences in plant establishment or grain quality between fungicide treatment (data not shown; protein (average 21%), oil (average 43%)).

In 2015 the fungicide trial was located at Coulta within an intensive canola cropping region with a potentially high Blackleg disease pressure. Establishment was unaffected by fungicide treatments, averaging 34 plants/m^2. Blackleg infection was lower in 2015 (av. 15%) compared to 2014 (av. 29%). There were no differences in Blackleg infection between fungicide treatments and also no differences in yield (Appendix 1 - Table 8).

The 2016 trial was located at Wangary within an intensive canola cropping region with a potentially high Blackleg disease pressure. Establishment was reduced by nearly 20% with Jockey on seed (Appendix 1 - Table 8), but plant numbers were still reasonable at 38 plants/m^2. Blackleg infection was moderate but quite variable across the site as were grain yields. Blackleg stem infection averaged 18% across the site. The blackleg stem infection was reduced by using both a seed dressing and an in-furrow fungicide in 2016, although this did not result in a yield increase (Appendix 1 - Table 8).

Grower Demonstrations 2014-2016

The farmer demonstrations undertaken in various regions across Eyre Peninsula over three seasons did not show large benefits in disease management, increases in plant growth or yield benefits. See Appendix 2 for seasonal reports.

Conclusions Reached &/or Discoveries Made

Wheat

Trials showed improvements in wheat grain yield through using a fluid form of phosphorous (phosphoric acid) over a granular product on highly calcareous sandy loam soils. Note that yield responses did not always translate to economic benefits. In wetter seasons the phosphorus source did not show a yield response. Similarly, in red sandy soils, in a drier season, phosphorus responses to phosphoric acid were observed, whereas no responses occurred in wetter seasons.

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.

In 2014 at Streaky Bay there were also differences in the early dry matter with phosphoric acid and manganese plus granular urea treatments having greater early growth. The tissue tests taken at mid tillering indicated low level zinc deficiency in some treatments at

Streaky Bay, but it was corrected with the trace element treatment. Manganese deficiency was not detected at this site in tissue tests, despite the treatments with added manganese having better early growth. 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, frequent 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.

The addition of 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 would increase the 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), balanced plant nutrition and/or sharper spring finishing conditions are limiting the response to fungicides compared to other regions. 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.

Canola

The canola nutrition trial in 2014 was the only year in which reliable nutritional data was collected and showed no differences in yield given the various nutrition application methods. The site had no nutrient deficiencies detected so providing trace elements in various forms had no yield benefits. The source of nutrients and application method, either fertiliser, in-furrow or foliar had no effect on the yield response at this site in 2014. However due to the failure of the other trial sites in 2015 and 2016, due to bird damage and poor plant establishment, further research into the effectiveness of fluid delivery of nutrients in canola should be undertaken before final conclusions are drawn.

In 2014 the fungicide treatments, when combined, did significantly increase yield over the nil fungicide control treatment, however the difference in blackleg disease levels scored was not significant. The application methods for blackleg fungicides trial in the 2015 and 2016 season have shown little or no change in either blackleg disease control or yield. The combined effect of fungicides giving additional protection has been reported in other research, and the early protection of plants is important to reduce blackleg infection early due to rain splash. Further evaluation with the newer fungicide products in the lower EP environment will continue. The selection of resistant varieties of canola with high blackleg ratings is important, as is paddock rotation with other break crops to lower the disease pressure.

Intellectual Property

No intellectual property generated

Application / Communication of Results

2018

- Presentation and discussion of final project outcomes and results at EP Farmer Meetings x 8 in March.

2017

- Discussion of final project outcomes at MAC Annual Field Day, Minnipa Ag Centre, 6 September. Article provided for field day booklet, distributed to all attendees.

2016

- Presentation of results at EP Farmer Meetings x 8 (Minnipa, Piednippie, Charra, Port Kenny, Buckleboo, Cowell, Cleve and Lock) 8-17 March, 127 people made up of 116 farmers, 10 agribusiness representatives, and 1 NRM staff member.
- Project discussion at MAC Annual Field Day, Minnipa Ag Centre, 7 September, 170 growers, advisors, and agribusiness representatives. Article provided for field day booklet, distributed to all attendees.

2015

- The results of the 2014 trials were presented at 8 Eyre Peninsula Farming Systems meetings held in March 2015, attended by 161 famers and 26 industry representatives at various locations (some combined groups) across upper Eyre Peninsula. Andy Bates and Craig James also presented nutrition information at the meetings, courtesy of the GRDC More Profit from Crop Nutrition project. The numbers at meetings were; Penong/Charra/Goode/Ceduna (23 growers, 2 representatives), Streaky Bay/Wirrulla/Mudamuckla (19, 3), Port Kenny/Elliston (17, 4), Minnipa (15, 2), Buckleboo/Kimba (23, 7), Wudinna/Kyancutta/Warramboo (12, 1), Franklin Harbour/Cowell (23, 3), Lock/Rudall/Darke Peak/Tuckey/Cleve/Wharminda (29, 4). Evaluation of these meetings and two project surveys were conducted using the SAGIT funded Keepads, results are available upon request from Naomi Scholz.

- Sticky beak days were held across upper Eyre Peninsula in September by 13 groups; 304 growers and 113 agribusiness representatives attended the events. The trial sites at Streaky Bay and Warramboo were visited and results presented on the Sticky Beak Days with plant roots available for visual assessment, and at two of the five farmer demonstrations (Cleve and Lock sites).

2014

- 13 Eyre Peninsula Farming Systems meetings held in March 2014 were attended by 234 famers and 20 industry reps at various locations across upper Eyre Peninsula. The numbers at meetings were; Penong/Charra/Goode/ Ceduna (32 growers, 4 reps), Wirrulla/Mudamuckla (18, 1), Port Kenny (10, 2), Elliston (12, 2 reps), Lock (21), Streaky Bay/Piednippie (8, 2), Minnipa (19), Crossville/Cleve (30, 6), Buckleboo (14), Wudinna/Kyancutta/Warramboo (20, 1), Franklin Harbour/Cowell (24,0), Darke Peak/Tuckey (13, 1) and Wharminda (13, 1).
- The Annual MAC Field Day was held on 3 September with 150 people attending. Amanda Cook presented information on fluid delivery systems and rhizoctonia.
- Sticky beak days were held across upper Eyre Peninsula in September by 15 groups; 357 growers and 130 agribusiness representatives attended the events. The trial sites at Streaky Bay and Warramboo were visited on the Sticky Beak Days and three of the five farmer demonstrations (Cleve site visited twice by two different groups – Cleve and Rudall).

The results were published annually (2015, 2016, 2017 and final report article in 2018) in the EPFS Summary which is distributed to farmers and agribusiness on EP, farmers in other low rainfall regions and the wider scientific community. See article list in Appendix. The trial results are searchable and available on the EPARF website and on the GRDC Online Farm Trials Database.

An article written for the 2014 Mallee Compendium - Fluid delivery systems and fungicides in wheat at Warramboo and Streaky Bay, A Cook**.**

Youtube video recorded with SAGIT (Bridget Penna).
Trial gauges success of fertiliser delivery mode - Amanda Cook EP ...
https://www.youtube.com/watch?v=LlzQ8mMitTk

POSSIBLE FUTURE WORK

The longer term impact of using fungicidal seed dressings or in-furrow products on soil biology such as beneficial fungi like AM's which increase phosphorus uptake, in low rainfall environments is not understood.

The grey calcareous soils of upper Eyre Peninsula still challenge production in this region due to nutritional tie-up, disease impacts and soil limitations, so further investigation is required to overcome these factors and improve these systems to maintain productive low input farming within these regional areas.

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APPENDICES

APPENDIX 1 Research trials

Fluid delivery in wheat

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.

Results

Soil type

Both soils have alkaline pH, reasonable soil phosphorus levels and adequate nutrient levels (Cu and Zn marginal at Streaky Bay) (Table 1). The main difference with these soil types 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 have been shown to be phosphorus responsive to phosphoric acid in previous research.

Table 1 Soil analysis of sites in 2016.

Location	Depth (cm)	pH (CaCl)	Colwell P (mg/kg)	PBI	Total soil N (kg/ha)	DTPA Cu (mg/kg)	DTPA. Mn (mg/kg)	DTPA. Zn (mg/kg)	Bicarb Sulphur (mg/kg)
Streaky Bay	0-10	8.5	24.7	206	28.9	0.14	1.60	0.24	15.6
	10-30	8.8	12.1	275	46.8	<0.1	0.87	<0.1	10.7
	Total reserves (0-100)				208.0				
Warramboo	0-10	8.7	18.1	84	16.6	0.20	2.61	0.83	4.7
	10-30	8.7	5.4	150	9.6	0.21	1.15	0.22	4.9
	Total reserves (0-100)				49.5				

Table 2 Rainfall and rhizoctonia inoculum level (pg DNA/g soil) at trial sites 2014-2016.

Site	Year	Total Rainfall (mm)	GSR (April-October) (mm)	Predicta B rhizoctonia inoculum level (pg DNA/g soil)
Warramboo	2014	302	190	51
	2015	326	237	150
	2016	333	251	6
	Long Term Average	*313*	*227*	
Streaky Bay	2014	441	277	745
	2015	249	212	208
	2016	485	323	201
	Long Term Average	*379*	*304*	

Seasonal conditions, plant establishment and early dry matter

Overall plant establishment showed no differences in the trials over the three seasons due to the fluid nutrition treatments. 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.

The **2014** season had late summer and good autumn rains with adequate soil moisture and early seeding in most areas. These conditions provided lush early crop growth and plants were not limited by moisture and had increased availability of nutrition, especially nitrogen and phosphorus, enabling greater root growth. This allowed the plants to grow through the impact of rhizoctonia root infection, especially at the Warramboo site. The trial at Warramboo had less rhizoctonia disease pressure and generally the trial was even with little disease expression. There were no 'stand out' treatments during the season, however the urea only treatment looked poor all season at both sites. There were no differences at Warramboo in the nutrition trial for early dry matter.

At Streaky Bay drier conditions at seeding and only spraying the green bridge out just before sowing as well as a high inoculum level resulted in rhizoctonia patches being present. At Streaky Bay there were differences in the early dry matter in the nutrition treatment on the grey calcareous soil with most phosphoric acid with granular urea treatments having better early growth. The phosphoric acid and 3 kg/ha manganese sulphate liquid and granular urea had significantly higher growth than the control. The tissue test taken at mid tillering showed some zinc deficiency at this site, with the trace element treatments having adequate levels.

In a poor season in **2015** at Streaky Bay the trial was very uneven and had patchy growth due to moisture stress early, lower germination as well as rhizoctonia disease expression. The Streaky Bay nutrition trial had visual differences in early growth with the phosphoric acid treatments looking better than other treatments. The fungicide trial was generally more even in growth earlier in the season than the nutrition trial, but rhizoctonia patches were still present. There were no treatments which were visually better in the fungicide trial during the season. There were no differences in early and late dry matter in the fungicide treatments in 2015, despite reasonable levels of rhizoctonia seminal and crown root infection.

There were no differences at Warramboo in dry matter in fungicide and nutrition treatments in 2015.

In **2016** at Streaky Bay plant establishment in ideal seeding conditions averaged 142 wheat plants/m^2 with no difference between treatments. Rhizoctonia patches were visible in the Streaky Bay trial early in the season, however disease symptoms were much lower than in previous years, as soil moisture stress was low and early nutrition and plant growth was not as limited. The Streaky Bay nutrition trial had no visual differences in early growth this season, unlike previous seasons when the phosphoric acid treatments looked better than other treatments. There were no differences in early or late dry matter attributable to the treatments in 2016 at Streaky Bay.

The trial at Warramboo was sown later due to low soil moisture, but had good plant establishment, with an average of 147 plants/m^2. There were no differences in plant establishment due to treatments applied at this site.

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 significant differences between the fungicides treatments imposed in the rhizoctonia root assessment taken at eight weeks, with 3.11 average seminal root infection, and average crown root infection of 69%. The application of fungicides in furrow did not perform better than fertiliser application or seed dressing at this site.

Rhizoctonia patches were present 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 in the root assessments due to the fungicides applied 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%) in the fungicide treatments in 2016 and the EverGol Prime (new formulation) with extra nitrogen also 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%).

Late Dry Matter, Grain Yield and Quality
In **2014** there were no differences at Streaky Bay in nutrition in yield measurements. Grain quality showed no differences between the treatments imposed, with the average shown in Table 3. The trial showed a 0.13 t/ha yield increase over 18:20:0:0 using phosphoric acid as the phosphorus source. The tissue tests taken at mid tillering indicated zinc deficiency in some treatments at Streaky Bay, but it was corrected with the trace

element treatment. Manganese deficiency was not detected at this site in tissue tests, despite the treatments with added manganese having better early growth. There were no significant differences in fungicide treatments, application method or rates.

At the Warramboo site in 2014 there were no 'stand out' treatments during the season, however the urea only treatment looked poor all season. There were no differences at Warramboo in the nutrition trial in dry matter or yield measurements in the trial. Grain quality showed no differences between treatments.

At Warramboo in 2014 in the fungicide trial there were differences in late dry matter and grain yield with three fungicide treatments plus trace elements having higher dry matter and yield. The split application of fungicides in furrow did not perform better than fungicide in furrow below the seed, seed dressing or fertiliser application at this site in the 2014 season. The grain quality showed no differences.

In **2015** at Streaky Bay the phosphoric acid treatments had visual better early growth and were the highest yielding. There were no treatments which were visually better in the fungicide trial during the season. There were no differences in early and late dry matter or yield in the fungicide treatments in 2015, despite reasonable levels of rhizoctonia seminal and crown root infection. The grain quality at Streaky Bay was not affected by treatments.

There were no differences at Warramboo in dry matter or grain yield in fungicide and nutrition treatments, with treatments averaging 3.0 t/ha (Figure 1). Grain quality showed no differences.

The trace element treatments or manganese treatments did not improve yield at either site in 2015.

In **2016** at Streaky Bay in a good season there were no differences in early or late dry matter or yield attributable to the nutrition treatments. Grain quality at Streaky Bay was not affected by treatments.

In 2016 at Warramboo only the phosphoric acid +with trace element +, fungicide (Uniform) split +and extra nitrogen treatment had higher late dry matter than the control (Table 4). The first five treatments in Table 5 had higher grain yields than the control and all of these had phosphoric acid as the base fertiliser. Grain quality showed no differences.

In previous seasons there has been a 0.11 t/ha (8% from 1.25 t/ha using granular DAP to 1.36 t/ha 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.

Table 3 Average grain quality tested of trial sites 2014-2016.

Site	Year	Protein (%)	Screenings	Test weight (hL)
Warramboo	2014	10.0	2.6	80.6
	2015	9.1	1.3	81.5
	2016	9.7	2.5	80.0
Streaky Bay	2014	10.3	1.6	80.2
	2015	10.8	5.3	82.4
	2016	9.8	1.0	80.0

Economics

The treatments were economically assessed using the following assumptions:

- The fuel, repairs and maintenance variable costs for putting in the trial are the same costs as those experienced by the closest 'farmer with the cost being $20/ha for fuel, $20/ha for repairs and maintenance and $3/ha for crop insurance.
- DAP was costed at $655/t (Port Lincoln) in 2014, $750/t in 2015 and 2016.
- Phosphoric acid was costed at $1,100/t (Miltaburra and Warramboo) or $46/ha in 2014, double the DAP cost, and APP (10:34:0:0) at $1275/t.
- Urea was costed at $560/t (Port Lincoln) in 2014 and 2015 and $445/t in 2016.
- UAN was costed at $2.30/L.
- The wheat price taken as Port Lincoln APW on 1 December each season and was $250/t in 2014, $252/t in 2015 and $193/t in 2016. Seed cost in the following year was calculated using the same price.
- Vibrance seed dressing at 360 ml/t was costed at $6/ha.
- The fungicide EverGol Prime was costed at $8.75/ha.
- The fungicide of Uniform was costed at $19.00/ha ($63.30/L)
- Chemical costs were $40.90/ha in 2014, $42/ha in 2015 and $45/ha in 2016.

Table 4 The input cost ($/ha) of the nutrition and fungicide treatments and gross margins imposed at Warramboo and Streaky Bay in 2014-15.

Warramboo	Variable costs* ($/ha)	P fertilser ($/ha)	Nitrogen +Trace Elements ($/ha)	Fungicide ($/ha)	Total Cost ($/ha)	Gross Margin for 2014#	Gross Margin for 2015#
DAP + Liquid Trace elements (TE)	99	38	15		152	398	584
Phosphoric acid + high Mn liquid + urea	99	43	26		168	329	570
Phosphoric acid + urea	99	43	23		165	327	553
Phosphoric acid, Mn liquid + urea	99	43	24		166	320	566
DAP + Foliar Mn	99	38	13		150	360	606
DAP + Foliar TE	99	38	15		152	355	581
APP, UAN + Foliar TE	99	53	15		167	294	545
DAP with Mn fertiliser	99	38	13		150	343	598
Control DAP at 50 kg/ha	99	38	11		148	356	608
DAP + TE + Uniform Split In-furrow	99	38	15	19	171	405	643
DAP + TE + Uniform on fertiliser	99	38	15	19	171	393	608
DAP + TE + Uniform + sedaxane seed dressing	99	38	15	25	177	385	569
DAP + TE + EverGol In-furrow	99	38	15	9	161	361	610
DAP + TE + EverGol Seed dressing	99	38	15	9	161	376	598
Streaky Bay - Nutrition							
Control DAP at 50 kg/ha	99	38	11		148	101	90

DAP + Liquid Trace elements (TE)	99	38	15		152	63	120
Phosphoric acid + high Mn liquid + urea	99	43	26		168	99	154
Phosphoric acid + urea	99	43	23		165	34	147
Phosphoric acid, Mn liquid + urea	99	43	24		166	48	160
DAP + Foliar Mn	99	38	13		150	108	102
DAP + Foliar TE	99	38	15		152	93	77
APP, UAN + Foliar TE	99	53	15		167	59	134
DAP with Mn fertiliser	99	38	13		150	93	119
Streaky Bay - Fungicide							
Control DAP at 50 kg/ha	99	38	11		148	96	161
DAP + TE + Uniform Split In-furrow	99	38	15	19	171	66	151
DAP + TE + Uniform on fertiliser	99	38	15	19	171	34	161
DAP + TE + Uniform + sedaxane seed dressing	99	38	15	25	177	65	171
DAP + TE + EverGol Seed dressing	99	38	15	9	161	98	172

**Variable costs are seed, chemical, repairs and maintenance, fuel and crop insurance*
#ASW wheat Port Lincoln 1 December 2014 $250/t and 2015 $252/t

Table 5 Fluid delivery trial growth measurements (dry matter), yield and gross margins for Mace wheat at Warramboo and Streaky Bay, 2016

Treatment	Warramboo Late DM (t/ha)	Warramboo Yield (t/ha)	Warramboo 2016 gross margin ($/ha)*	Streaky Bay Late DM (t/ha)	Streaky Bay Yield (t/ha)	Streaky Bay 2016 gross margin ($/ha)*
Phosphoric acid + urea + Liquid Trace elements (TE) + Uniform Split In-furrow + extra N	6.77^{a}	2.41^{a}	243	7.46^{a}	2.62^{a}	279
Phosphoric acid + urea + TE + new penflufen Split In-furrow + extra N	6.39^{ab}	2.36^{ab}	**	6.53^{abc}	2.37^{abcd}	**
Phosphoric acid + urea + TE	5.82^{bcde}	2.28^{abc}	254	$5.4^{\#}$	$2.36^{\#}$	270
Phosphoric acid + urea + high Mn	6.15^{abc}	2.27^{abcd}	253	$5.71^{\#}$	$2.34^{\#}$	266
Phosphoric acid + TE + Uniform Split In-furrow	5.44^{cdef}	2.27^{abcd}	233	6.82^{ab}	2.37^{abcd}	251
DAP + TE + new penflufen	5.36^{def}	2.23^{bcde}	**	5.65^{bcd}	2.16^{bcdef}	**
DAP + TE + Uniform	5.17^{ef}	2.16^{cdef}	227	5.55^{bcd}	2.41^{abc}	277
Phosphoric acid + urea + Mn	6.37^{ab}	2.16^{cdef}	233	$5.66^{\#}$	$2.42^{\#}$	283
DAP + TE + triadimenol on fertiliser	5.40^{cdef}	2.15^{cdef}	244	5.75^{bcd}	2.00^{f}	215
DAP + TE + Uniform + sedaxane seed dressing	5.36^{def}	2.15^{cdef}	219	4.87^{d}	2.12^{cdef}	211
DAP + TE + Uniform	5.15^{ef}	2.15^{cdef}	225	5.49^{bcd}	2.09^{def}	215
DAP + TE and new formulation penflufen Split In-furrow	5.24^{ef}	2.13^{cdef}	**	5.37^{bcd}	2.18^{bcdef}	**
DAP + TE + flutriafol on fertiliser	5.39^{cdef}	2.13^{cdef}	240	5.35^{bcd}	2.35^{abcde}	284

DAP + Foliar TE	6.04 [abcd]	2.13 [cdef]	240	6.38[#]	2.39[#]	284
Phosphoric acid + urea + TE + new penflufen Split In-furrow	5.58 [cde]	2.13 [cdef]	**	5.70 [bcd]	2.46 [ab]	**
DAP + TE	4.79 [f]	2.12 [def]	238	6.17[#]	2.33[#]	278
Control DAP at 50 kg/ha	5.63 [bcde]	2.08 [ef]	233	6.39 [abcd]	2.21 [bcdef]	258
DAP + TE + EverGol Prime seed dressing	5.16 [ef]	2.08 [ef]	221	5.19 [cd]	2.05 [ef]	207
Phosphoric acid + urea	5.92 [bcde]	2.08 [ef]	219	6.34[#]	2.38[#]	277
APP + UAN + TE	5.55 [cdef]	2.06 [f]	220	6.38[#]	2.39[#]	284
DAP with Mn fertiliser	5.44 [cdef]	2.03 [f]	222	6.18[#]	2.34[#]	282
DAP + Foliar Mn	5.44 [cdef]	2.02 [f]	220	5.73[#]	2.45[#]	303
LSD (P=0.05)	*0.77*	*0.15*		*1.57*	*0.31*	

**ASW wheat Port Lincoln 1 December 2016 $193/t, Urea $445/t Port Lincoln February 2016*
***new formulation of penflufen, cost unknown.*
[#] Streaky Bay nutrition trial data – trial analysed separately - no significance at LSD (P=0.05).

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Fluid delivery systems for canola

SAGIT funded a project to assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. Fluid systems have the potential to increase production through more effective delivery of micro and macro nutrients, use of lower cost trace element sources and improved control of cereal and canola root and leaf diseases.

Blackleg continues to be a major issue facing canola growers especially on lower Eyre Peninsula and fluid delivery systems for fungicides may increase production and improve disease control. With the development of new fungicides and the technology to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products. This trial compared the relative benefits of a range of fungicide strategies for blackleg control on canola compared to current practices.

The individual trials in the given seasons for this project are reported in Eyre Peninsula Farming Systems Summary 2016, *Fluid delivery systems in canola* p77, Eyre Peninsula Farming Systems Summary 2015, *Fluid delivery systems in canola* p118 and Eyre Peninsula Farming Systems Summary 2014, *Fluid delivery systems in canola* p104.

Results

Canola nutrition – Coulta 2014

Table 6 Dry matter and grain yield for Pioneer 45Y86 (CL) in Coulta canola nutrition trial, 2014.

Treatment	Early dry matter (kg/m^2)	Yield (t/ha)	Oil (%)	Protein (%)
Phosphoric acid + urea + Mn	0.12	1.49	42.5	21.0
DAP + low Foliar TE	0.10	1.33	42.8	20.9
APP + UAN	0.10	1.33	43	21.0
APP, UAN + TE	0.07	1.31	43.4	21.3
DAP+ TE	0.10	1.25	43.3	20.7
Control	0.09	1.25	42.9	20.7
Phosphoric acid + urea + Mn	0.10	1.24	42.8	21.2
Phosphoric acid + urea + high Mn	0.08	1.22	43	20.9
DAP and Foliar TE	0.06	1.20	42.7	21.0
Phosphoric acid	0.08	1.17	43	20.8
DAP and Foliar Mn	0.07	1.14	42.6	20.7
DAP with Mn coated fertiliser	0.08	1.09	42.1	21.3
Urea only	0.05	0.99	42.8	20.8
Phosphoric acid low	0.10	0.94	42.4	21.1
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*

The average yield of the different fertiliser types, granular or fluid; APP and UAN, phosphoric acid, granular DAP or urea only (Table 2) showed no differences at this site in 2014.

Table 7 Average yields of CL canola with different nutrition treatments at Coulta trial, 2014.

Fertiliser source	Yield (t/ha)
APP + UAN	1.32
Control	1.24
Phosphoric acid	1.21
DAP	1.20
Urea only	0.99
LSD (P=0.05)	*ns*

Table 8 Canola establishments, blackleg score and yield for CL canola with fungicide treatments in Coulta trial, 2014-16.

	2014			2015			2016		
Fungicide treatment	**Canola establishment (plants/m²)**	**Blackleg score (% infection)**	**Yield (t/ha)**	**Canola establishment (plants/m²)**	**Blackleg score (% infection)**	**Yield (t/ha)**	**Canola establishment (plants/m²)**	**Blackleg score (% infection)**	**Yield (t/ha)**
Intake (in-furrow)	48.3	15.7	1.33 ab	35.0	11.1	2.01	39.7 ab	22 a	2.38
Intake (on fertiliser)	41.7	35.8	1.30ab	38.6	15.1	2.08	41.8 ab	12 bc	2.68
Intake (in-furrow) and Jockey (on seed)	40.6	12.0	1.63a	32.7	10.2	2.18	38.3 b	9 c	2.15
Jockey (on seed)	42.8	34.8	0.98 b	39.9	22.4	1.87	38.3 b	23 a	2.04
Control - DAP @ 100 kg/ha	45.6	33.0	0.99 b	29.7	12.6	2.09	47.1 ab	20 ab	1.87
Aviator Foliar	*			*			47.1 ab	14 abc	2.29
Prosaro Foliar	*			*			57.5 a	18 abc	2.32
LSD (P=0.05)	*ns*	*ns*	*0.35*	*ns*	*ns*	*ns*	*10.9*	*9.6*	*ns*

*Product was not available

APPENDIX 2 Farmer demonstrations

2015 Farmer fungicide demonstration strips

Why do the demonstration?
A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrients and disease control strategies in current farming systems. A part of the project was to provide farmer support (5 farmers annually) to monitor paddock demonstration strips to evaluate economic benefits of changes in products within fluid delivery systems.

How was it done?
Farmers applied fluid nutrition and/or fungicide products within broad acre paddocks using fluid systems and different nutrient mixes depending on their individual systems. None of these systems implemented split application of the fungicide products, all were applied with or below the seed.

Within each of the treated areas of the paddock, and an untreated control, four sampling lines were established to measure and collect data. Six paddock demonstrations were monitored; Graeme and Heather Baldock, Buckleboo, Andrew and Jenny Polkinghorne, Lock, Matt and Amanda Price, Cleve, Darren, Georgia and Caroyln Mudge, Miltaburra, Peter Kuhlmann, Mudamuckla and Bruce and Kathy Heddle, Minnipa. Plant establishment, dry matter, rhizoctonia seminal and crown root scores, grain yield and quality were measured in the treated and nil strips.

Plants were sampled 8 weeks after the sowing date to be assessed for root disease and early dry matter. Paddock patch score for rhizoctonia is a visual score (0-5) of the number plants out of 5 plants affected by rhizoctonia (400 plants scored per treatment) across 4 transects measured at the same time. Rhizoctonia seminal root scores were measured using 0-5 root scoring rating (McDonald and Rovira, 1983) of 80 plants per treatment across 4 transects and tops of plants were collected, dried and weighed for dry matter. Crown roots were also counted on the same plants with the number of roots infected with rhizoctonia used to calculate % crown root infection.

Buckleboo
The paddock was sown on 8 May with Mace wheat@ 60 kg/ha pre-treated with Rancona C as seed dressing with the District Practice treatment being 18:20:0:0 @ 60kg/ha and $ZnSO_4$ @ 2 L/ha, UAN @ 20 L/ha and Flutriafol at 200 ml/ha. Uniform was added to the fluid at 300 ml/ha. The initial rhizoctonia inoculum level was high risk at 109 pg/DNA g soil, and all other disease levels were below detection levels. Eight 20m strips were harvested with the plot header in each seeder run and the yield data from broad acre header was also obtained.

Lock
The paddock BB9 was last sown on 2 June with Hindmarsh barley @ 55 kg/ha with the control being fluid fertiliser with 8 units P, 23 units N as urea and elemental rates of trace elements dissolved as 1kg zinc monosulphate, 2kg of manganese sulphate, 100 g of copper sulphate plus Intake (flutriafol) @ 200 ml/ha. The rhizoctonia fungicide treatment was Uniform at 300 ml/ha. The initial rhizoctonia inoculum level was high risk at 139 pg/DNA g soil and low levels of *Pratylenchus neglectus*, with all other diseases below detection levels. Eight 20m strips were harvested with the plot header in each seeder run.

Cleve

Broad acre strips were sown on 6 May with Emu Rock wheat @ 65 kg/ha with control having 40 kg/ha 18:20:0:0 and 30 L/ha UAN. Uniform was applied at rates of 150, 300 or 450 ml/ha. A soil wetter demonstration at two rates was also monitored. The initial rhizoctonia inoculum level was low risk at 10 pg/DNA g soil and low levels of *Pratylenchus neglectus*, with all other disease levels below detection levels. This was a second year cereal following a canola crop in 2013. No extra nitrogen was added to the demonstration area. The plot header was used to harvest eight 20m strips within the treatments and grain quality was analysed.

Miltaburra
Paddock 18C at Miltaburra was sown on 7 May with Cobra wheat at 60 kg/ha, pickled with Vitaflo C. Fluid fertiliser was applied as phosphoric acid at 70L/ha resulting in 6 units P, 10 of N (urea) and 0.5 kg/ha zinc sulphate. Uniform was applied in alternating strips at 380 ml/ha. Urea was applied at 40 kg/ha to given treatments at seeding.

The initial rhizoctonia inoculum level was high risk level at 423 pg/DNA g soil, *Pratylenchus neglectus* risk was also high and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each treatment.

Mudamuckla
Paddock 12 at Mudabie was sown on 10 May with Mace wheat treated with Raxil seed dressing using variable rate technology (Rx) with three different rates of seed and urea depending on the paddock zone. The rates were 50 or 55 kg/ha of seed and urea at rates of 0, 15, 22 kg/ha. Fluid fertiliser was applied at 50L/ha resulting in 5.3 units P, 200g elemental zinc and Flutriafol at 200 ml/ha.

Uniform was applied at 300 ml/ha run to compare to the nil treatments. The runs were approximately 1.5 km x 25.4 m wide. The initial rhizoctonia inoculum level was high risk level at 423 pg/DNA g soil, *Pratylenchus neglectus* risk was also high and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each treatment.

Minnipa
Paddock 12 at Minnipa was sown on 14 May with Emu Rock wheat with18:20:0:0 @ 55 kg/ha and Raxil T @ 0.2 L/ha and Triad at 0.2 kg/ha. Uniform was applied at 300 ml/ha run to compare to the standard treatments. The initial rhizoctonia inoculum level was low risk level at 25 pg/DNA g soil, *Pratylenchus neglectus and P. thornei* were low risk. Eight 20 m strips were harvested with the plot header in each treatment.

Results
The 2015 season had a dry start and seeding occurred on minimal moisture in most western regions resulting in poor conditions for early crop growth and an average season (Decile 5). Central and Eastern Eyre had good seeding conditions, good early crop growth resulting in an above average season.

The farmers implemented the addition of the fungicides and other fluid products within their current farming practices, with different fluid fertiliser mixes which prevents a direct comparison of all the farmer demonstrations.

Table 1 Farmer fungicide demonstrations averages for Buckleboo, 2015.

Treatment	Plant Establishment (plants/m^2)	Early DM (g/plant)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infection	Number crown roots	Late DM (g/m row)	Plot header yield (t/ha)	Broad acre yield (t/ha)

					(%)				
Nil Control	125	2.2	0.7	3.9	86.5	8.2	108	1.37	0.99
Uniform 300 ml/ha	130	2.4	0.6	3.8	86.2	7.9	120	1.59	0.99

Table 2 Farmer fungicide demonstrations averages for Lock, 2015.

Treatment	Plant Establishment (plants /m²)	Early dry matter (g/ plant)	Rhizoctonia seminal root score (0-5)	Crown root infection (%)	Rhizoctonia disease patch score (0-5)	Late dry matter (g/m row)	Plot header yield (t/ha)
Control	123	0.47	3.1	54.8	1.8	0.21	3.03
Uniform 300 ml/ha	133	0.42	2.9	45.6	2.3	0.18	3.05
Uniform 300 ml/ha + Intake	141	0.38	3.4	58.4	2.4	0.21	2.86

Table 3 Yield and grain quality of farmer fungicide demonstrations, Cleve 2015.

Fluid mix	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection (%)	Late Dry Matter (t/ha)	Plot header yield (t/ha)	Plot header yield (t/ha) with hill area
Standard + Flutriafol (200 ml/ha)				0.97 d	1.89 cd	1.89 bc
Standard + Sulphate 7L/ha (Zn 71g/L Mn 57g/L Cu 10g/L)				1.36 abc	2.00 bc	2.00 a
Standard + Chelate Amino Acid (Zn 40g/L Mn 30g/L Cu 10g/L)				1.17 cd	1.77 d	1.77 c
Standard + 9L/ha soil conditioner (Zn 40g/L Mn 30g/L Cu 10g/L)				1.33 abc	1.88 cd	1.88 bc
Standard + 4L/ha soil conditioner (Zn 40g/L Mn 30g/L Cu 10g/L)				1.29 abc	1.95 bc	1.84 bc
Standard - 65 kg/ha Emu Rock, 40 kg/ha 18:20, 30 L/ha UAN	0.97	3.9	70.4	1.21 bc	1.97 bc	1.98 a
Standard + Uniform 150 ml/ha	0.76	3.9	72.29	1.41 a	1.98 bc	
Standard + Uniform 300 ml/ha	0.73	3.9	68.82	1.23 abc	2.04 ab	
Standard + Uniform 450 ml/ha	0.79	4.0	70.67	1.28 abc	2.00 bc	
Standard + Rancona Dimension 200 ml/ha	0.93	4.0	71.32	1.39 ab	1.92 bc	
Standard + Rancona Dimension + Flutriafol 200 ml/ha	1.33	4.0	71.33	1.17 cd	2.14 a	
Standard				1.42 a	1.99 bc	
LSD (P=0.05)	*0.3*	*ns*	ns	*0.02*	*0.13*	*0.09*

Table 4 Plant growth and root disease levels of farmer fungicide demonstrations, Miltaburra 2015.

Treatment	Run	Plant establishment (plants/m²)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infection (%)	No. crown roots	Plot yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)
Standard (70 L/ha = 6 units P, 10 of N (urea) and 0.5 kg/ha zinc sulphate)	3,5,7	127	1.54	3.03	70.0	3.9	0.84	11.1	3.7	78.7
Uniform 380ml/ha	4,6,8	124	1.77	2.96	68.8	3.3	0.69	11.4	5.0	78.1
Uniform plus 40 kg/ha Urea	19 on hill	137	2.83	2.83	74.4	3.0	1.06	10.2	3.2	78.9
Uniform with no extra Urea	19						0.73	12.9	4.9	77.5
Standard +20 kg/ha urea	11						0.83	12.5	4.2	77.6
Uniform + Standard +20 kg/ha urea	10						1.04	11.3	2.3	78.8
P (50 L/ha =4.3 units P) + Uniform	14						0.57	11.9	5.0	78.7
LSD (P=0.05)							*0.10*	*0.7*	*ns*	*1.09*

Table 5 Plant growth and root disease levels of farmer fungicide demonstrations, Mudamuckla, 2015.

Treatment	Early DM (g/ Plant)	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection (%)	No. crown roots	Plot yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/ hL)
Phos acid +300 ml/ha Uniform	0.15	1.8	3.8	82.4	3.6	1.09	9.5	3.5	82.7
Phos Acid	0.15	1.6	3.5	76.6	3.5	1.06 ns	9.4	3.5	82.7

Table 6 Plant growth and root disease levels of farmer fungicide demonstrations, Minnipa, 2015.

Treatment	Early DM (g/ Plant)	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection (%)	No. crown roots	Plot header yield (t/ha)
300 ml/ha Uniform and Vibrance seed dressing	0.48	1.10	3.22	62	4.4	1.70
Nil	0.46	1.15	3.08	68	3.8	1.70

Conclusion

Initial rhizoctonia inoculum levels were high in most paddocks except Cleve, a second year cereal after canola, and Minnipa following a grass free medic.

In the 2015 season there were little difference in rhizoctonia disease expression and yield response with the use of fluid delivery systems with fungicides. The seeding conditions were drier and may have limited the ability of the plants to grow away from the disease, and the dry spring conditions may have limited yield responses. At Miltaburra a nitrogen response was improved with fluid products, this will be further investigated in trial research in 2016.

2016 Farmer fungicide demonstration strips

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrients and disease control strategies in current farming systems. A part of the project was to provide farmer support (5 farmers annually) to monitor paddock demonstration strips to evaluate benefits of changes in products within fluid delivery systems.

Farmers applied fluid nutrition and/or fungicide products within broad acre paddocks using fluid systems and different nutrient mixes depending on their individual systems. Baldock's at Buckleboo implemented a split application of the fungicide products this season which was monitored, all other applications were with or below the seed.

The growers were encouraged to set up the demonstrations with a nil or control treatment strip for treatment implemented. Within each of the treated areas of the paddock, and an untreated control, four sampling lines were established to measure and collect data. Six paddock demonstrations were monitored; Graeme and Heather Baldock, Buckleboo, Andrew and Jenny Polkinghorne, Darren and Georgie Mudge, Miltaburra, Peter Kuhlmann, Mudamuckla and Phil and Jan Wheaton, Streaky Bay. Plant establishment, dry matter, rhizoctonia seminal and crown root scores, grain yield and quality were measured in the treated and nil strips. Pete Kuhlmann's paddock was not monitored during the season due to blockages at seeding which resulted in the fluid rates being lower and variation in early plant growth.

Plants were sampled 6-8 weeks after the sowing date to be assessed for root disease and early dry matter. Paddock patch score for rhizoctonia is a visual score (0-5) of the number plants out of 5 plants affected by rhizoctonia (400 plants scored per treatment) across 4 transects measured at the same time. Rhizoctonia seminal root scores were measured using 0-5 root scoring rating (McDonald and Rovira, 1983) of 80 plants per treatment across 4 transects and tops of plants were collected, dried and weighed for dry matter. Crown roots were also counted on the same plants with the number of roots infected with rhizoctonia used to calculate % crown root infection.

Buckleboo

The paddock, Siding Road, was sown in mid- May with Mace wheat@ 60 kg/ha pre-treated with Rancona C as seed dressing with the District Practice treatment being 18:20:0:0 @ 60kg/ha and $ZnSO_4$ @ 2 L/ha and UAN @ 20 L/ha. Uniform was added to the fluid at 300 ml/ha. The initial rhizoctonia inoculum level was high risk at 162 pg/DNA g soil, and all other disease levels were below detection levels. Eight 20m strips were harvested with the plot header in each seeder run and the yield data from broad acre header was also obtained.

Lock

The paddock, Peru, was sown on 24 May with Fathom barley @ 55 kg/ha with the control being fluid fertiliser with 8 units P, 43 units N as urea and elemental rates of trace elements dissolved as 1kg zinc monosulphate, 2kg of manganese sulphate, 100 g of copper sulphate. The rhizoctonia fungicide treatment was Uniform at 300 ml/ha. The initial rhizoctonia inoculum level was high risk at 222 pg/DNA g soil with all other diseases below detection levels. Eight 20m strips were harvested with the plot header in each seeder run.

Miltaburra

Paddock 5P at Miltaburra was sown on 16 June with Mace wheat at 60 kg/ha. Fluid fertiliser was applied at 70L/ha water rate with phosphoric acid resulting in 5.5 units P, 4.6 units of N (10 kg of dissolved urea), 1 kg Zn sulphate (33%) and 0.5 kg Mn. Uniform was applied in alternating strips, but went out at too high a rate, approximately 550 ml/ha. The paddock was sprayed with 1L/ha Triflurx, 1L Optimax and 200ml/ha Ester 680 pre seeding. The initial Rhizoctonia inoculum level was high risk level at 207 pg/DNA g soil and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each treatment.

Mudamuckla

Paddock 64 at Mudabie was sown on 19 April with Grenade wheat at 50 kg/ha and 20 kg/ha of urea. Fluid fertiliser is applied at 50L/ha resulting in 5.3 units P, 200g elemental zinc and Flutriafol at 200 ml/ha. Uniform was applied at 300 ml/ha. Unfortunately a different product than normal was used, and reacted with the mix causing blockages in lines and only delivered approximately 40% of the desired rates of fluids. The initial Rhizoctonia inoculum level was high risk level at 396 pg/DNA g soil and all other disease levels were below detection levels. This paddock was not monitored during the season as there were differences in early growth due to the fluid delivery.

Streaky Bay

Paddock No. 3 at Streaky Bay was the last sown on 9 June with Compass barley at 70 kg/ha, with18:20:0:0 @ 70 kg/ha. The fluid system was used to deliver various treatments using a 60 L/ha water rate. Uniform was applied at 300 ml/ha run to compare to the standard treatments. The initial Rhizoctonia inoculum level was high risk level at 254 pg/DNA g soil and all other disease levels were below detection levels. The paddock was sprayed with Lontrel 25ml/ha and LVE 500 ml/ha. Eight 20 m strips were harvested with the plot header in each treatment.

Results

The 2016 season was above average in most regions. Summer rainfall resulted in stored soil moisture and early sown crops developed quickly, growing away from rhizoctonia, before cold winter conditions slowed growth. Frost was an issue in some areas, however above average rainfall and a mild spring resulted in ideal grain filling conditions and maximised grain yields with very low screenings.

The farmers implemented the addition of the fungicides and other fluid products within their current farming practices, with different fluid fertiliser mixes which prevents a direct comparison of all the farmer demonstrations.

Table 1 Farmer fungicide demonstrations averages for Buckleboo, 2016.

Treatment	**Establishment (plants/m²)**		**Early dry matter (t/ha)**		**Rh paddock patch score (0-5)**		**Average Rhizoctonia seminal root score (0-5)**	
	Split	**Not split**	**Split**	**Not split**	**Split**	**Not split**	**Split**	**Not split**
Flutriafol	110.6	104.7	0.0047	0.005	1.43	1.40	3.07	3.13
Nil	110.9	108.4	0.0052	0.0055	1.13	0.94	3.07	3.05
Uniform	112.6	113.6	0.0057	0.0056	1.60	0.87	3.00	2.89
Treatment	**Average crown roots**		**Crown root infection (%)**		**Late dry matter (t/ha)**		**Yield (t/ha)**	
	Split	**Not split**	**Split**	**Not split**	**Split**	**Not split**	**Split**	**Not split**
Flutriafol	4.38	4.33	63.8	62.9	3.07	3.13	2.07	1.89
Nil	5.29	4.84	67.6	63.5	3.07	3.05	2.07	1.92
Uniform	4.21	3.61	60.4	60.6	3.00	2.89	2.17	2.19

Table 2 Farmer fungicide demonstrations averages for Lock, 2016.

Treatment	**Plant Establishment (plants/m²)**	**Early dry matter (g/ plant)**	**Rhizoctonia seminal root score (0-5)**	**Crown root infection (%)**	**Rhizoctonia disease patch score (0-5)**	**Late dry matter (g/m row)**	**Plot header yield (t/ha)**
Control	99.7	0.64	3.19	46.8	1.27	10.52	3.44
Uniform 300 ml/ha	110	0.51	3.20	47.3	1.57	10.25	3.40

Table 3 Plant growth and root disease levels of farmer fungicide demonstrations, Streaky Bay 2016.

Treatment	***Plants/m²**	**Early dry matter (t/ha)**	**Rh paddock patch score (0-5)**	**Average Rhizoctonia seminal root score (0-5)**	**Crown root infection (%)**	**Late dry matter (t/ha)**	**Yield (t/ha)**	**Protein (%)**	**Screenings (%)**
Nil	127	0.0051	1.9	3.08	68.3	3.96	1.44	10.5	0.11
Uniform 300ml/ha	120	0.0050	2	3.16	63.3	4.35	1.57	10.3	0.10
Uniform plus Roloader (Zn,Cu, Mn +	144	0.0054	1.3	3.09	66.7	3.98	1.78	10.4	0.08

microbes)									
Uniform Roloader Hummer (charcoal base product)	143	0.0066	1.4	3	64.4	4.82	1.73	10.2	0.10
Trace Element mix 2 kg/ha Zn 1 kg/ha Mn 1 kg/ha Cu	133	0.0057	1.4	2.9	51.8	4.67	1.64	10.5	0.13
Uniform Hummer plus TE	141	0.0051	1.6	3	53.9	4.42	1.75	10.3	0.11
Wetcit (soil wetter) Uniform Hummer plus TE	145	0.0045	1.7	3	64.3	3.51	1.48	10.1	0.09

*Variation in sowing depth – early germination variable

Table 4 Plant growth and root disease levels of farmer fungicide demonstrations, Miltaburra, 2016.

Treatment	***Plants /m²**	**Early DM (t/ha)**	**Rh patch score (0-5)**	**Seminal root score (0-5)**	**Crown root infection (%)**	**Late DM (t/ha)**	**Plot yield (t/ha)**	**Protein (%)**	**Screenings (%)**
Phos acid + 550 ml/ha Uniform	95.5	0.0016	1.88	2.78	72.0	4.30	1.68	10.1	0.03
Phos Acid	96.2	0.0018	2.03	2.83	69.3	4.44	1.60	9.9	0.03

Conclusion

Initial rhizoctonia inoculum levels were high in most paddocks in 2016 despite summer rainfall which may lower inoculum levels if adequate weed control is undertaken. Given the early start to the season in most areas and adequate moisture most paddocks established well, had access to adequate soil nutrition and grew through the rhizoctonia, with low levels of visual patches in crops.

Again in 2016 there were little difference in rhizoctonia disease expression and yield response with the use of fluid delivery systems with fungicides. The split application of the fungicides at Buckleboo has not shown advantages in this environment in 2016.

Over the three seasons the farmer demonstrations have been monitored there have been no benefits in disease management, crop growth or yield detected in various regions of Eyre Peninsula.

APPENDIX 3 Project impact survey

<u>Knowledge, awareness, skills and attitudes (KASA) survey results</u>

Twenty seven people (EPARF members via mail chimp mail out on 17 August 2017) completed the survey (only open for 11 days) conducted via Survey Monkey. One reminder was sent on the last day of the survey being open, this generated an extra 10 respondents. Average time taken to complete survey: 3 minutes. Research results were not included as part of the survey introduction, but we did remind people about the aim of the project and where they may have seen or heard the project being presented.

Q1: Just over half of the respondents remembered hearing about the project. Room for improvement? This project was presented at a lot of events and has been published in the EP Farming Systems Summary – the survey did not ask if people attended these events or read the publications. Given that respondents in this survey did so electronically, it may be a good idea to do a targeted electronic release of the project outcomes to capture this audience.

Q2: Half of the respondents had either changed or planned to change to a fluid delivery system. 37% had considered changed but decided to stay with a granular system. Three people had never thought about it.

Q3: A random list of statements were provided, people could select as many statements as applied to their situation, and also use the 'other' option for further comment. Six people made further comment, with half of those positive about fluid delivery, and the other half listing more barriers to fluid delivery adoption. The most selected option was 'I wanted to be able to deliver trace elements at seeding', followed equally by 'I wanted to make delivery of trace elements/phosphorus/fungicides easier' and 'the cost of upgrading machinery put me off'. Thirty percent wanted to be able to deliver fungicides at seeding, and 27% were glad they had changed to a fluid delivery system.

Q4: Have the results from the project influenced your decision making process? Thirty percent said no, 26% said yes, 19% were not sure and 26% said they had not seen the results. There is an opportunity to individually distribute the results of the project overall via the EPARF member list and I recommend we do this in the near future. A summary article of the three years of work will also be included in the Eyre Peninsula Farming Systems Summary 2017, due out in March 2018.

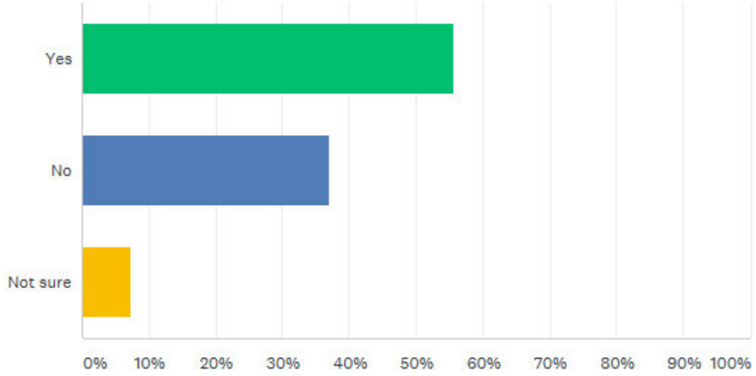
Full results of the survey are listed below.

Q1

Customize | Export

Have you heard about the SAGIT Fluid Delivery project being conducted by Amanda Cook at Minnipa Agricultural Centre?

Answered: 27 Skipped: 0



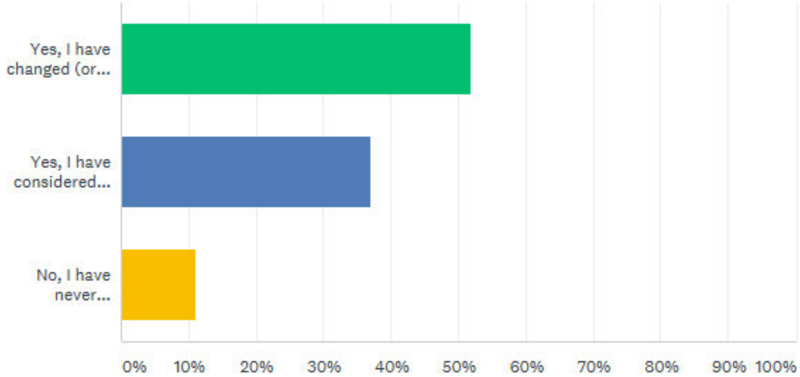
ANSWER CHOICES	RESPONSES	
Yes	55.56%	15
No	37.04%	10
Not sure	7.41%	2
TOTAL		27

Q2

Customize | Export

Have you considered changing to a fluid delivery system on your seeder?

Answered: 27 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes, I have changed (or plan to change) to a fluid delivery system	51.85%	14
Yes, I have considered changing but decided to stay with my granular delivery system	37.04%	10
No, I have never considering changing my delivery system	11.11%	3
TOTAL		27

Q3

Customize Export

Which comments apply to you regarding fluid delivery systems? (select multiple answers if applicable)

Answered: 26 Skipped: 1

ANSWER CHOICES	RESPONSES	
Not applicable, I never considered it	3.85%	1
I wanted to make delivery of trace elements/phosphorus/fungicides easier	42.31%	11
I wanted to change my source of phosphorus from granular to phosphoric acid or APP	15.38%	4
I wanted to be able to deliver trace elements at seeding	57.69%	15
I wanted to be able to deliver fungicides at seeding	30.77%	8
The cost of upgrading machinery put me off	42.31%	11
Having to learn a new system put me off	7.69%	2
There is not enough evidence of benefits in my situation	23.08%	6
There was enough evidence of benefits in my situation	11.54%	3
I am concerned about the safety issues of handling acid	19.23%	5
I tried fluids but then went back to granular	3.85%	1
I'm glad I changed to a fluid delivery system	26.92%	7
I wish I had never changed to a fluid delivery system	0.00%	0
I am getting great results with a fluid delivery system	15.38%	4
I am not seeing any differences in using a fluid delivery system	7.69%	2
Total Respondents: 26		

Comments (6)

Showing **6** responses

I'm under the impression that the extra cost of liquid fert offsets any positive yield increase, I am definitely interested in liquid fert though

8/28/2017 8:04 PM View respondent's answers

Would like to change to in the future

8/28/2017 7:19 PM View respondent's answers

It is a whole new system requiring half a man at seeding to make it happen easily. Not only the fluid delivery system but a vat to tow, another truck in the system a pump and batching plant to operate all time consuming.

8/28/2017 12:47 PM View respondent's answers

Gut feel that fluid trace is the go

8/28/2017 12:15 PM View respondent's answers

Cost of Nitrogen per unit of N is higher for liquids.

8/18/2017 8:01 PM View respondent's answers

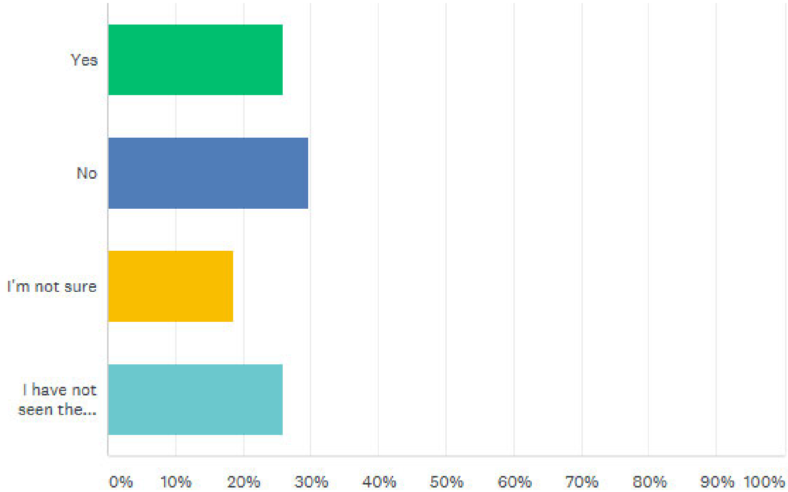
work man are put off using acid and it is a pain if you get a problem in the delivery system desling with acid

Q4

Customize Export

Have the results from the project influenced your decision making process?

Answered: 27 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	25.93%	7
No	29.63%	8
I'm not sure	18.52%	5
I have not seen the results	25.93%	7
TOTAL		27

Q5

Export

Any further comments?

Answered: 8 Skipped: 19

Showing 8 responses

Can we get a copy?

8/28/2017 12:15 PM View respondent's answers

We may not be improving yeilds with our system but have reduced our cost of production, often saving a boomspray pass post emergent.

8/19/2017 10:37 PM View respondent's answers

I would like to start with trace elements, not sure about phos acid at this time, not sure about fungicides

8/18/2017 10:58 PM View respondent's answers

Will probably go liquid as well as granular 3 tank when we can afford to upgrade the seeder to a new unit.

8/18/2017 8:01 PM View respondent's answers

if phosphorus in app came down in price might go back to using fluid

8/18/2017 9:10 AM View respondent's answers

No

We have used fluid for 11 years now so before current research (from bob's days)

8/17/2017 9:32 PM View respondent's answers

no

8/17/2017 7:00 PM View respondent's answers

Making the change to fluid fertilisers - Baldock

Case Study *May 2015*

EPARF
Eyre Peninsula Agricultural Research Foundation Inc.

KEY POINTS

- Yield increases with fluid fertiliser cannot be expected on certain soil types.
- Fluids allow flexibility to strategically and easily apply trace elements.
- Buffering of water is important when mixing products.
- Extra labour is required in order to mix and transport fluid products.
- Logistical challenges at seeding surround the need for an additional truck to transport fluids.

FAST FACTS

Farmer: Graeme and Heather, and Tristan and Lisa Baldock

Location: North-west of Buckleboo, SA

Property size: 5600 hectares

Soil type: Red-brown sandy loam, grey sandy loam

Avg. annual rainfall: 295 mm

Avg. growing season rainfall: 210 mm

Main crops and yields: Wheat 1.4 t/ha, barley1.5 t/ha, field pea 0.8 t/ha and canola as an opportunity crop

Background

The Baldocks manage 5600 arable hectares north west of Kimba near Buckleboo. After getting out of sheep in 2009, they crop between 4800-5000 hectares annually.

Why the shift to fluids was made

Following three years of drought and the application of blanket rates of fertiliser, in 2009 the Baldocks decided to try variable rate technology for both fertiliser and seed. By applying no fertiliser on the heavier soils and increasing rates on better growing soil, they felt that gross margins could be improved. In addition, using a no-till system and with zinc responsive soils, the Baldocks felt that spraying zinc on the soil surface was not a good option, and that putting it down the tube would be better.

Tristan Baldock, Buckleboo

The Baldocks were aware, through their involvement with the Buckleboo Farm Improvement Group (BIG FIG) and SARDI Minnipa Agricultural Centre, that their soils were not responsive to liquid P like grey calcareous soils.

The 2009 season was profitable and provided the opportunity to purchase a new air cart for 2010, which was when they started to put other nutrients down the tube.

"The shift to fluids allowed us to more strategically target our trace element applications."

The fluid system

The Baldock's unit was purpose-built with LQS systems (liquid injection pump and control modules that can be retrofitted) on both the air cart and seeder bar. They initially used only zinc sulphate mixed with water and the system performed well. In 2011 the Baldocks began adding UAN and fungicides. They occasionally had issues with some mixes turning to 'sugar' and blocking filters and terminal jets, so they changed to a capillary-type system, also a LQS product. This was done at the same time as upgrading the seeder bar to a Seed Hawk. All cereals and canola are sown with fluids. The Baldocks also conduct their own on-farm trials comparing crops with and without fluids.

While UAN is more expensive per unit than urea, the Baldocks feel it better suits their system.

"As almost continuous croppers, nitrogen is an issue so we've elected to use a base fertiliser of DAP and support it with extra UAN for more nitrogen."

Advantages

The fluids system allows the easy application of fungicides and the Baldocks have found that not having to spray for rust in some years has been an advantage. The use of fluids has allowed the easy and efficient application of zinc, a deficient trace element in the Baldock's soil types.

"We now apply zinc every year whether we need it or not because it is cheap and easy. This is maintaining a good level of zinc in the soil."

Learning points

Like any system change, there can be initial issues that contribute to the learning experience. For the Baldocks, most of these related to compatibility issues with mixing. They say when using zinc on its own, the system worked well and was simple.

Full sowing system set up

Sowing point

Fluid cart and seeder box

It wasn't until they started mixing UAN and fungicides that they began to have problems.

> *"In the past we have had all sorts of trouble with mixing products resulting in blocked filters and nozzles. Since then we have learnt about buffering the water first, but it would have been good if we had researched that earlier!"*

Agitation and ensuring the fluids are thoroughly mixed can be problematic. However, one of the biggest disadvantages of the Baldock's system is that when the rate of fertiliser is varied, the rate of fungicide and the trace elements is also varied, meaning rates could not be changed independently. Having only one solution on board has caused them to investigate how they can adapt the system.

Other drawbacks Graeme identified to the use of fluids in their farming system included:

- The expense of using UAN (per unit) compared with urea.
- To keep the supply of product up to the seeder at sowing time requires another labour unit, equivalent to at least a 0.5 full-time role.
- Logistics can be more difficult to manage, such as when needing to shift the extra truck in the paddock.

Future plans

The Baldocks are looking at splitting the application of fluids, particularly when using fungicides, to ensure that half is pushed below the seed and half is applied on top of the seed. This will mean adjusting the delivery system by splitting the line and putting another delivery hose on each tyne. However if this cannot be done simply, a duplicated system would need to be set up on the bar, resulting in further costs. Even so, the Baldocks will continue to use a fluid system.

> *"Now the system is set up and infrastructure is in place we just need to do minor modifications to improve efficiency. This year we have added another cartage tank and 'quick mix' hopper to the truck and greatly improved our agitation system on the air cart. We anticipate new insecticides, fungicides and fertiliser products being available in the future."*

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Making the change to fluid fertilisers - Patterson

EPARF
Eyre Peninsula Agricultural Research Foundation Inc.

Case Study *May 2015*

KEY POINTS

- Yield advantages can be gained by using fluids on highly calcareous soils.
- The Central Eyre Peninsula Fertiliser Buying Group achieves reduced prices for fluid products for members and provides a good information exchange for growers.
- Mixing issues with fluids can arise and strategies are needed to address them should they arise.
- Safety issues are an important consideration.
- Use of fluids has freed up space in the seeder box and negated the need for additional fertiliser storage.
- Fluids allow flexibility to strategically and easily apply trace elements and fungicides.
- Logistical challenges and extra labour may arise transporting fluid products to paddock.
- Additional water tanks might be required to avoid stress on bores or mains.

FAST FACTS

Farmer: Simon and Tanya Patterson

Location: Piednippie

Property size: 12,000 hectares

Soil type: Grey calcareous loam

Avg. annual rainfall: 366 mm

Avg. growing season rainfall: 295 mm

Main crops and yields: Wheat, barley and medic pastures

Farming system: No-till disc pasture-cereal rotation with sheep

Background

Simon and Tanya Patterson together with partners Andrew and Dianne Patterson of Wirrulla have 8,500 arable hectares around Piednippie and south of Wirrulla on Eyre Peninsula, South Australia. They also lease another 2,100 ha of arable land nearby. They crop between 5,500 and 6,500 hectares annually with one machine. Soils types are predominantly grey calcareous loams with occasional red clay flats.

The Pattersons have been using fluids since 2008.

Simon Patterson, Piednippie

Why the shift to fluids was made

After previously experimenting with fluid fertilisers on the basis of the significant yield increases achieved in Dr Bob Holloway's (Minnipa Agricultural Centre) 2000 trial results, the catalyst for the Pattersons to completely change to a fluid system came in 2007 with the sudden spike in granular fertiliser prices. Already having a fluid cart and most of the system already in place, the change was a 'no-brainer'.

"The price of granular fertiliser almost doubled and the price of liquid phosphorus just stayed the same. It worked out to be considerably cheaper per unit of P than it was for granular fertiliser."

Early on the Pattersons found that crops sown with liquid fertilisers would grow really well early in the season, but those crops sown with granular products would yield approximately the same in the end. Since then the Pattersons have refined their system and are beginning to see yield differences.

"Now we are adding a bit more phosphorus and nitrogen and trying to get it to continue to yield better towards the end of the season - and it seems to be working."

In both independently undertaken un-replicated trials and replicated trials run by SARDI Minnipa Agricultural Centre, the crop strips sown with liquid fertiliser strips out-yielded those using DAP (18:20:0:0) by approximately 0.25 t/ha. This has given Simon the confidence that they are going down the right track.

The fluid system

Full sowing system set up

The Pattersons use a no-till disc seeding system. They built their own 6800 litre fluid cart which is towed behind both the air seeder bin and air seeder bar. Simon says that this user friendly system is hooked up and runs the pump hydraulically from the tractor. A ZYNX X20 (precision agriculture system) controls the fluid cart and is set up as a fourth liquid bin. This allows rates to be changed simply from the tractor cabin and automatically switches on and off at the ends of runs in conjunction with the seeder, eliminating wastage. It is matched to enable filling times to coincide, minimising stopping and starting, and allowing problems with blockages to be temporarily dealt with on the go. Whilst Simon admits more is required in terms of hydraulic power, he can be assured that the rates he is applying are accurate and this system has advantages over ground-driven pumps.

"If you want to change your rate, it is simply a matter of turning a knob. Also sometimes when I am three quarters of the way through a tank and filters start blocking, I can adjust the hydraulics up to get more pressure instead of stopping and cleaning it all out. As we sow around the clock, this is a huge advantage for us, allowing us to continue sowing and deal with blockage issues in daylight. Whereas with a ground driven one, you could be losing your rate and only be putting it on at 45 litres, if you were trying to get 60 litres per hectare."

The Pattersons use phosphoric acid at a rate of 14 litres to 50 litres of water per hectare. Added to that is 420 grams of elemental zinc in the cheapest available form at the time - usually zinc monohydrate.

Advantages

One of the key advantages the Pattersons see to using a fluid system is the ability to strategically apply micro nutrients really simply.

"We see the benefit of being able to put zinc or whatever nutrient you want, over every hectare of the cropping program really easily. I think that we are getting as much benefit from having zinc freely available in our soil as we are by having the phosphorus freely available as you are supplying a continuous stream of nutrients there for the crop to take up as soon as it puts it roots in the ground."

Fluid delivery system

The Pattersons also feel that use of fluids has added a degree of flexibility to their program, because as they are applying phosphorus and nitrogen at separate points, rates can be easily adjusted or micronutrients added.

Simon says that due to less soil disturbance of their disc machine, they have issues with Rhizoctonia which can be managed through fungicide use. Whilst patches still occur, he says, yields are increasing and more consistent on the patches, due to the use of fungicides.

The use of fluid fertiliser has freed up space in the Patterson's air seeder box which can now be used for seed, increasing the amount of time seeding before filling up. It also negates the need for fertiliser sheds, as the phosphoric acid is stored in 1000 litre shuttles.

As members of the Central Eyre Peninsula Buying Group, the Pattersons feel that not only are they getting a cheaper price for their fertiliser product, but they are reassured by the confidence that being part of a group brings.

> *"It takes the pressure off me having to make the decision on which day I pull the trigger on my phosphorus input. As a buyers group we meet and put it out to tender, and they come back to us with the best price and then we choose not always the best price - but the most reliable best price. It gives us the confidence to know that we are getting a reasonable price and not being messed over by big business - we make the decision, we decide when we want it and who we want to deal with."*

Learning points

For all the advantages experienced by the Pattersons, they do say that the use of fluids adds a level of logistical complexity to their seeding and additional safety considerations.

> *"Instead of having just one truck to handle grain and fertiliser you have another truck in the paddock transporting the liquid. So every time we fill up, there are three people there - one person filling the air seeder with seed and urea, one person checking over the machine, and one person filling the liquid set up. However, we only fill up every 4 or 5 hours and run our machine around the clock. We are doing around 1000 acres in 24 hours."*

The Pattersons only pre-mix water and zinc and the phosphoric acid remains in its shuttle in concentrated form until it is ready to be used. They use a Venturi system that as the water is being pumped into the fluid cart, it sucks the acid out of the shuttles and mixes it as it is going into the tank.

On occasions, water supply has been an issue. Using both mains and bores for supply, the demands of trying to spray and mix phosphoric acid has meant that the Pattersons have run out of water sometimes. They have had to put in a few more tanks so that they are not always relying on one bore or main.

The Pattersons did encounter some issues with settling out and blocked nozzles when they were stopping at night time. However, since moving to around the clock sowing, the problem has reduced. Increasing the water rates and more agitation has also greatly improved this issue.

> *"Before we went to around the clock sowing, we would just keep going until the tank was empty and then start it up again the next morning and flush it and fill it up again. This seemed to eliminate blockage issues."*

Future plans

This year the Pattersons plan to add manganese in place of or in addition to zinc. However having tried this in the early days when using ammonium polyphosphate, they experienced "nightmare" blockages. Now using the more acidic phosphoric acid, Simon is confident it will all stay in suspension and that lifting their water rates has seemed to help with reducing blockages.

The Pattersons say that they will continue to use a fluid system, and even if they reverted to using a granular base product, they would still tow a liquid cart in order to put on trace elements.

> *"Every year we try a few different things and it seems to be getting better. It is a reasonably robust system and pretty user friendly."*

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EPARF
Eyre Peninsula Agricultural Research Foundation Inc.

Making the change to fluid fertilisers - Polkinghorne

Case Study *May 2015*

KEY POINTS

- Significant yield advantages can be gained by using fluids on highly calcareous soils.
- Mixing issues with fluids can arise.
- The Central Eyre Peninsula Fertiliser Buying Group achieves reduced prices for fluid products for members and provides a good information exchange for growers.
- The corrosive nature of phosphoric acid impacts on fittings.
- More preparation at seeding is required in order to mix and transport fluid products.
- Safety issues are an important consideration.

FAST FACTS

Farmer: Andrew and Jenny Polkinghorne, Tim Polkinghorne and Ellen Hardy

Location: 15 km north Lock, SA

Property size: 6,700 hectares

Soil type: Grey calcareous sand

Avg. annual rainfall: 333 mm

Avg. growing season rainfall: 253 mm

Main crops and yields: Wheat, barley, canola and medic pastures

Farming system: No-till fluid system

Background

Andrew and Jenny Polkinghorne, together with son Tim and partner Ellen farm 6,700 hectares north of Lock on Eyre Peninsula, South Australia. Comprising some of the last cleared land in the district, the soils are predominately grey calcareous sand of high pH (8.7). The Polkinghornes crop approximately 5,800 hectares per year and have 1 full time employee.

Andrew Polkinghorne and Monique Spiers

Why the shift to fluids was made

In early 2000, based on trial results of Dr Bob Holloway of SARDI Minnipa Agricultural Centre, the Polkinghornes made the switch to fluid fertiliser. On soils with high pH and calcium carbonate content yields could be significantly increased using fluids compared to those achieved using granular fertilisers, primarily due to the increased availability of phosphorus. The Polkinghornes were confident that on their soil types a shift to fluids could increase phosphorus efficiency and therefore increase yield.

In addition, trial work had shown that use of fluids could address trace element deficiencies such as zinc, inherent on grey calcareous soils. Andrew feels that using fluids gives them another way of getting trace elements on that might otherwise be fixed (not available to plants) very quickly.

"Shifting into fluids has given us the biggest yield increase of any technology or practice change that we have been able to implement."

Full sowing system set up

The fluid system

The Polkinghornes started using fluid fertilisers in 2003 and have used them to sow the full cropping program every year since. They use phosphoric acid as a base fertiliser together with granular nitrogen. Trace elements (manganese, zinc and copper) are dissolved into the phosphoric acid.

"We have looked around at other fertilisers that might be more suitable, but we haven't found anything that fits the bill better than the phosphoric acid. Ammonium poly phosphate is an option but it is significantly more expensive and is limited in its ability to be able to mix trace elements with it and that is still important to us."

Stating that their system was relatively simple to put into operation, they initially purchased a 7000 litre liquid cart and pump to put behind their air seeder, tanks for storage of fluid fertiliser and for transportation to the paddock. The Polkinghornes admit that it was a significant expense, but the most expedient way of doing it at the time. They modified their bar to deliver fluids using distribution equipment initially imported from Canada and a simple ground driven pump.

"We chose to use tanks because we wanted to pre-mix trace elements with phosphoric acid. We wanted to have it pre-mixed so that it wasn't a job that we had to do during seeding."

Since 2003 they have upgraded pumps and distribution systems to include electronic pump controllers and monitors that were not available for liquids when they initially set up their system.

Advantages

One of the advantages of moving to a fluid system has been the formation and involvement with the Central EP Fertiliser Buying Group. Comprising a membership of 35 farming businesses, they work together to achieve significantly reduced prices for fluid products compared to acting individually. The group also provides a good source of information exchange amongst farmers.

Fluid cart at rear

"Being part of the Central Eyre Fertiliser Buying Group and learning from other farmers has been a very positive experience as a result of shifting to fluids."

In more recent times, the Polkinghornes have used fungicides to address certain disease issues such as Rhizoctonia and yellow leaf spot (YLS). They feel that the use of a fluid system increases the ease of fungicide application and allows a tailored approach with the ability to turn on or off and adjust rates. For Rhizoctonia, 2014 trial results on their farm did not show a yield increase, possibly due to a particularly dry spring, however less Rhizoctonia patch was observed. Similarly, as the Polkinghornes grow a large proportion of wheat on wheat, the ease of application of fungicide provides a level of insurance against disease.


Fluid delivery (yellow hose)

Besides the yield benefits achieved through the use of fluid fertilisers, the Polkinghornes feel that the additional dry matter production is having benefits, particularly on poorer soils. Anecdotally, they say that these poorer soils are producing better than they used to and seem to be more robust in terms of production.

Andrew says that at seeding time the use of fluids frees up space in his air seeder box, negating the need for a bigger air seeder.

Learning points

As phosphoric acid is highly corrosive, the Polkinghornes learnt very quickly what materials will or won't handle phosphoric acid. 316 stainless steel or high quality poly propylene type fittings are needed for use with phosphoric acid, however they also differ in quality and this has been a learning experience.

At seeding time more preparation is required in order to mix the fluids before transportation to the paddock and mixing issues are sometimes a problem in themselves. However, Andrew says that most of the problems they have encountered arose from trying to mix something else with a fluid that doesn't mix, but provided you stick to the rules there is not much problem.

"We had some troubles with Flutriafol until we clearly understood the need for a higher water rate. We now use Flutriafol without any issues."

With an extra flat bed truck fitted with fluid tanks required in the paddock, logistical challenges arise when shifting paddocks. Andrew says this is due to their set up - whilst not insurmountable, can make things more complicated.

Personal safety is one of the biggest issues associated with the use of phosphoric acid - in particular, eye protection. You can get it on your skin and like normal fertiliser, if you have a cut on your finger, it will sting, but as long as you wash it off straight away, there is no real issue.

Future plans

The Polkinghornes will continue using fluids.

> *"We feel the benefits of our fluid system outweigh the negatives by a long shot."*

Further information

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Farmer fungicide demonstration strips

Amanda Cook, Ian Richter and Wade Shepperd
SARDI, Minnipa Agricultural Centre

DEMO

Searching for answers

Location:
Buckleboo
Graeme and Heather Baldock
Rainfall
Av. Annual: 295 mm
Av. GSR: 210 mm
2014 Total: 298 mm
2014 GSR: 201 mm
Yield
Potential: 2.2 t/ha (W)
Actual: 1.4 t/ha
Paddock History
2014: Mace wheat
2013: Mace wheat
2012: Chemical fallow
Soil Type
Brown sandy loam

Location:
Lock - Andrew, Jenny and Tim Polkinghorne
Rainfall
Av. Annual: 333 mm
Av. GSR: 253 mm
2014 Total: 350 mm
2014 GSR: 254 mm
Yield
Potential: 3.5 t/ha (W)
Actual: 2.9 t/ha
Paddock History
2014: Mace wheat
2013: Medic pasture
2012: Hindmarsh barley
Soil Type
Grey calcareous sandy loam

Location:
Cleve
Matt and Amanda Price
Rainfall
Av. Annual: 402 mm
Av. GSR: 220 mm
2014 Total: 290 mm
2014 GSR: 209 mm
Yield
Potential: 2.7 t/ha (B)
Actual: 2.6 t/ha
Paddock History
2014: Scope barley
2013: Mace wheat
2012: Justica wheat
Soil Type
Red loam

Key messages

- **In the 2014 season there were no significant yield advantages recorded at five sites across upper Eyre Peninsula when using the fungicide products over the nil treatments. This was in a season with an early start and minimal stress during crop establishment, and at sites with high Rhizoctonia inoculum levels.**
- **The broad acre farmer demonstrations in the 2014 season showed no visual differences or early plant growth measured at the given sites during the cropping season.**
- **There were differences in the level of crown root infection at Cleve, where the nil treatment had a higher number of crown roots infected and a greater % of crown root infection than the fungicide treatments.**
- **There were differences between treatments recorded in the mid-May sown barley crop at Piednippie in Rhizoctonia patch score and the seminal root score.**
- **Differences in protein, screenings and test weights were recorded between treatments at several sites with a general trend of lower yields having higher protein, higher screenings and lower test weights.**
- **Further evaluation of research trials and farmer demonstrations using new fluid products and fungicide placement, will occur over two more seasons to evaluate the economics of using fungicides in low rainfall farming systems.**

Why do the demonstration?

Caring for Our Country funding was obtained to demonstrate the impact of new fungicides for Rhizoctonia suppression by monitoring farmer broad acre strips in their current farming systems in 2014.

How was it done?

Farmers applied fungicide products within broad acre paddocks using fluid systems and different nutrient mixes depending on their individual systems. None of these systems implemented split application of the fungicide products, all were applied with or below the seed.

Within each of the treated areas of the paddock, and an untreated control, four sampling lines were established to measure and collect data. Five paddock demonstrations were monitored; Graeme and Heather Baldock, Buckleboo, Andrew and Jenny Polkinghorne, Lock, Matt and Amanda Price, Cleve, Simon and Tanya Patterson, Piednippie and Peter Kuhlmann, Mudamuckla. Plant establishment, dry matter, Rhizoctonia seminal and crown root scores, grain yield and quality were measured in the treated and nil strips.

Plants were sampled 8-9 weeks after the sowing date to be assessed for root disease and early dry matter. Paddock patch score for Rhizoctonia is a visual score (0-5) of the number plants out of 5 plants affected by Rhizoctonia (400 plants scored per treatment) across 4 transects measured at the same time. Rhizoctonia seminal root scores were measured using 0-5 root scoring rating (McDonald and Rovira, 1983) of 80 plants per treatment across 4 transects and tops of plants were collected, dried and weighed for dry matter. Crown roots were also counted on the same plants with the number of roots infected with Rhizoctonia used to calculate % crown root infection.

Disease

Location:
Piednippie
Simon Patterson
Rainfall
Av. Annual: 366 mm
Av. GSR: 295 mm
2014 Total: 374 mm
2014 GSR: 284 mm
Yield
Potential: 4.4 t/ha (B)
Actual: 1.57 t/ha
Paddock History
2014: Fleet barley
2013: Scout wheat
2012: Medic pasture
Soil Type
Grey calcareous sandy loam

Location:
Mudamuckla
Peter Kuhlmann
Rainfall
Av. Annual: 291 mm
Av. GSR: 216 mm
2014 Total: 369 mm
2014 GSR: 293 mm
Yield
Potential: 3.8 t/ha (W)
Actual: 1.5 t/ha
Paddock History
2014: Mace wheat
2013: Mace wheat
2012: Axe wheat
Soil Type
Grey calcareous sandy loam

Buckleboo
The paddock was sown on 6 May with Mace wheat@ 60 kg/ha pre-treated with Rancona C as seed dressing with 18:20:0:0 @ 60kg/ha and $ZnSO_4$ @ 2 L/ha and UAN @ 20 L/ha. The paddock was top-dressed with 40 kg/ha of urea on 3 August. Uniform was added to the fluid at 200, 300 or 450 ml/ha rates. The initial Rhizoctonia inoculum level was high risk at 719 pg/DNA g soil, and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each seeder run and the yield data from broad acre header was also obtained.

Lock
The paddock was sown on 16 May with Mace wheat @ 55 kg/ha with the control being fluid fertiliser with 8 units P, 13.8 units N as urea and elemental rates of trace elements dissolved as 1 kg zinc monosulphate, 2 kg of manganese sulphate, 150 g of copper sulphate plus flutriafol @ 200 ml/ha. The Rhizoctonia fungicide treatment was applied with APP (ammonium polyphosphate) at 30 L/ha, UAS (urea ammonium sulphate (28% N)) at 25 L/ha and Uniform at 325 ml/ha. The initial Rhizoctonia inoculum level was medium risk at 60 pg/DNA g soil, Crown rot and Take-all were high risk, and low levels of *Pratylenchus neglectus*, with all other diseases below detection levels. Seven 20 m strips were harvested with the plot header in each seeder run and the yield data from the broad acre header was also obtained.

Cleve
Broad acre strips were sown on 11 May with Scope barley@ 45 kg/ha with control having 40 kg/ha 18:20:0:0, trace element mix 60:40:20 ZMC@10 L/ha and 20 L/ha UAN. Uniform was applied at 200, 300 or 400 ml/ha with all having 360 ml Vibrance seed dressing and Agriphar experimental product was applied at four rates of 160, 320, 480 or 640 ml/ha (Table 4). The initial Rhizoctonia inoculum level was high risk at 113 pg/DNA g soil, Crown rot and Take-all were medium level risk, with all other disease levels below detection levels. The plot header was used to harvest 20m strips within the treatments and grain quality was analysed.

Piednippie
Paddock 6 at Piednippie was sown on 20 May with Fleet barley at 60 kg/ha with a fluid fertiliser system using 4 units of phosphorus as phosphoric acid, 12 kg/ha of nitrogen as granular urea, 450 g/ha Zn and Intake Hiload Gold @150ml/ha. Uniform at 280 ml/ha and Agriphar Experimental product at @ 270 ml/ha was applied in strips with the fertiliser the same as the rest of the paddock. The initial Rhizoctonia inoculum level was in the high risk range at 314 pg/DNA g soil and all other diseases were below detection levels. Eight 20 m strips were harvested with the plot header in each seeder run and the yield data from the broad acre header was also obtained.

Mudamuckla
Paddock 25 at Mudabie was sown on 26 April with Mace wheat treated with Raxil seed dressing using variable rate technology (Rx) with three different rates of seed, phosphoric acid and urea depending on the paddock zone. The rates were 40, 50 or 55 kg/ha of seed, rates of 3.2, 5 or 6.3 kg P/ha as phosphoric acid and urea at rates of 0, 15, 22 kg/ha. Flutriafol was applied at 100 ml/ha and zinc monosulphate at 330 g/ha on the whole paddock.

A run with the standard rate of input, phosphoric acid at 5 kg P/ha, was included to compare with the normal practice variable rate runs. Uniform was applied at 300 ml/ha in a variable rate run and the standard rate (5 kg P/ha) run to compare to the nil treatments. The runs were approximately 1.5 km x 25.4 m wide. The initial Rhizoctonia inoculum level was high risk level at 105 pg/DNA g soil, Crown rot risk and *Pratylenchus thornei* risk were also high and all other disease levels were below detection levels. Eight 20 m strips were harvested with the plot header in each treatment and the yield data from the broad acre header was also obtained on 21 November, and the paddock grain protein averaged 10.2%.

What happened?
The 2014 season with early summer and good autumn rains resulted in adequate soil moisture and early sowing, providing exceptional conditions for early crop growth. The plants were not limited by moisture and the increased availability of nutrition, especially nitrogen and phosphorus, enabled greater root growth. This allowed the plants to grow through the impact of Rhizoctonia root infection due to soil moisture and nutrition not being as limiting as in other seasons.

The farmers implemented the addition of the fungicides within their current farming practices, with different fluid fertiliser mixes which prevents a direct comparison of all the farmer demonstrations.

At Buckleboo the initial Rhizoctonia inoculum level was in the high risk category.

Table 1 Farmer fungicide demonstrations, Buckleboo 2014

Treatment	Early DM (g/plant)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infection (%)	Number crown roots	Late DM (g/m row)	Plot header yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)	Broad acre yield (t/ha)**
Nil Control	0.55	1.51	2.86	74.4	7.7	112	1.39	12.2	1.2	84.3	1.75
Uniform 200 ml/ha	0.6	1.68	2.86	78.5	8.8	122	1.36	13.6	1.0	83.7	1.75
Uniform 300 ml/ha	0.56	1.7	2.91	75.8	7.4	72	1.16	14.5	1.0	83.2	1.68
Uniform 450 ml/ha	0.55	1.69	2.93	69	8.4	82	1.25	14.1	1.2	83.3	1.81
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*0.09*	*0.7*	*ns*	*0.4*	*ns*

**(0=nil damage, 5=all seminal roots with spear tips) **Average of two separate runs*

This demonstration had different rates of Uniform applied, and the Uniform 300 ml/ha treatment coincided with high barley grass numbers. There were no differences in the plant growth parameters or disease infection levels at this site. The plot header yields were significantly different with the Uniform 300 ml/ha area being lower, possibly due to the higher grass competition. There were no significant differences in the broad acre paddock yields taken as an average of the two runs, although the Uniform 300 ml/ha area was lowest. There were differences in protein and test weight with the highest yielding Nil treatment having the lowest protein and highest test weight of grain, due to the dilution of protein in the grain (Table 1).

At Lock the initial Rhizoctonia inoculum level was medium risk but Crown rot and Take-all were high risk. In this demonstration the differences in fertiliser mixes of APP and phosphoric acid, do not allow a direct comparison of the effect of the fungicide treatment (Table 2). There were no differences detected in early growth or root disease levels. There were differences in late dry matter, yield and grain quality but we are unable to determine if this is a fertiliser or fungicide effect.

At Cleve the initial Rhizoctonia inoculum level was high risk with Crown rot and Take-all at a medium level risk. With a base granular fertiliser this extensive demonstration compared different nutrition and fungicides at different rates. The early dry matter, Rhizoctonia patch score and seminal root scores measured were not significant, but the % of crown root infection and the number of crown roots were significant (Table 3). The Nil treatment had a greater % crown root infection and a greater number of crown roots compared to the Uniform treatments.

There were no differences in plot header yields but protein, screenings and test weights differed with a general trend of lower yield having higher protein, higher screenings and lower test weight (Table 4).

Table 2 Farmer fungicide demonstrations, Lock 2014

Treatment	Run	Early dry matter (g/plant)	Rhizoctonia seminal root score (0-5)	Crown root infection (%)	Late dry matter (g/m row)	Plot header yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hL)	Broad acre yield (t/ha)**
APP, UAS, Uniform 325 ml/ha	23	1.15	2.4	65	153	3.16	11.7	7.0	82.5	2.82
Phos acid, UAS, Flutriafol, TE	24	1.25	2.8	65	193	2.91	12.5	7.5	81.4	3.01
Phos acid, 25 kg/ha Urea, Flutriafol	22	-	-	-	-	2.75	10.9	4.0	84.0	2.92
LSD (P=0.05)		*ns*	*ns*	*ns*	*17*	*0.13*	*0.3*	*1.3*	*0.8*	-

**(0=nil damage, 5=all seminal roots with spear tips) **Average of two separate runs*

Table 3 Plant growth and root disease levels of farmer fungicide demonstration at Cleve, 2014

Treatment	Early DM (g/plant)	Plants/m^2	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection	Number crown roots	Late DM (g/m row)
Nil –Run 19	0.8	82.5	1.02	2.8	68.8	6.2	170
Uniform 200 – Run 20	0.96	66	1.26	2.76	60.4	4.8	188
Uniform 300 – Run 21	0.87	77	1.45	2.81	58.4	4.0	200
Uniform 400 – Run 22	0.81	72	1.36	2.9	59.3	3.8	198
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*7.9*	*0.8*	*ns*

Table 4 Yield and grain quality of farmer fungicide demonstrations, Cleve 2014

Fluid mix	Seed treat-ment	Plot header yield (t/ha	Protein (%)	Screenings (%)	Test weight (kg/hL)
Normal – 300 ml/ha flutriafol, 10 L/ha trace element, 20 L/ha UAN	No	2.60	11.2	4.1	74.2
Nil Control - 10 L/ha trace element, 20 L/ ha UAN	No	2.69	11.1	3.5	74.9
200 ml/ha Uniform , 10 L/ha trace element, 20 L/ha UAN	360ml Vibrance	2.76	10.3	2.3	74.8
300 ml/ha Uniform, 10 L/ha trace element	360ml Vibrance	2.74	10.8	3.4	74.5
400 ml/ha Uniform, 10 L/ha trace element	360ml Vibrance	2.76	11.5	6.4	73.3
160 ml/ha Agriphar Experimental, UAN and Trace	No	2.72	10.8	2.7	73.4
320 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.72	9.8	2.0	74.1
480 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.41	10.0	2.2	74.4
640 ml/ha Agriphar Experimental, 10 L/ha trace element	No	2.72	9.7	2.5	73.8
10 L/ha trace element, 20 L/ha UAN	No	2.59	9.4	2.9	74.4
Normal – 300 ml/ha flutriafol, 10 L/ha trace element, 20 L/ha UAN	No	2.66	8.9	2.2	75.0
LSD (P=0.05)		*ns*	*0.73*	*1.6*	*1.0*

At Piednippie the initial Rhizoctonia inoculum level was a high risk level. This demonstration used a base fluid fertiliser of phosphoric acid and granular urea and compared different fungicides. The paddock had some grass weeds present and was the latest sown of all the demonstrations on the 20 May. There were differences in the Rhizoctonia patch score and the seminal root score with the Uniform treatment having the lowest (Table 5). There were also differences in the number of crown roots with Intake Hiload Gold having lower numbers. There were no differences in plot header yields at this site at the 5% significance level. There were differences in protein, screenings and test weights again with a general trend of lower yield having higher protein and higher screenings.

At Mudabie variable rate technology is used over different paddock zones using 3 different rates of phosphoric acid, urea and seeding rates. A standard run using 5 kg P/ha as phosphoric acid was also included to compare the use of the fungicide Uniform. The initial Rhizoctonia inoculum level was in the high risk range at 105 pg/DNA g soil, Crown rot risk and *Pratylenchus thornei* risk were also high. This was the earliest paddock sown in the demonstrations. There were no significant differences in early dry matter or root disease measurements.

There were differences in plot header yields with the phosphoric acid and Uniform treatment being lowest, but this may have also been a slight nitrogen response due to added urea.

Table 5 Plant growth and root disease levels of farmer fungicide demonstrations, Piednippie 2014

	Early DM (g/ plant)	Rh patch score (0-5)	Seminal root score (0-5)*	Crown root infection (%)	Number crown roots	Plot yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/ hL)	Broad acre yield (t/ ha)**
Intake Hiload Gold 150 ml/ ha	0.34	2.1	3.2	70.2	2.9	1.79	9.0	0.37	66.5	1.60
Uniform @ 280 ml/ha	0.29	1.9	2.9	78.3	3.4	1.78	9.2	0.46	66.6	1.66
In furrow fungicide	0.37	2.1	3.1	76.2	4.2	1.76	9.5	0.50	67.6	1.42
Agriphar Experimental 270 ml/ha	0.27	2.5	3.0	77.4	3.9	1.46	9.6	0.64	68.1	1.63
LSD (P=0.05)	*ns*	*0.3*	*0.2*	*ns*	*0.6*	*ns*	*0.34*	*0.13*	*1.1*	-

**(0=nil damage, 5=all seminal roots with spear tips) ** (average of two strips)*

Table 6 Plant growth and root disease levels of farmer fungicide demonstrations, Mudamuckla 2014

Treatment	Run	Early DM (g/ plant)	Rh patch score (0-5)	Seminal root score (0-5)	Crown root infection (%)	No. crown roots	Plot yield (t/ ha)	Protein (%)	Screenings (%)	Test weight (kg/ hL)	Broad acre yield (t/ ha)**
Rx (VRT)	8	0.41	1.54	2.5	60	8.6	2.09	10.0	1.2	85.5	1.53*
Rx (VRT) +300 ml/ha Uniform	9	0.41	1.38	2.6	73	9.9	2.30	9.9	1.6	85.6	1.50
Phos Acid	10	0.56	1.51	2.4	66	9	2.10	10.0	1.6	85.4	1.57
Phos acid +300 ml/ha Uniform	11	0.48	1.50	2.7	65	8.8	1.88	9.7	1.3	85.4	1.57
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*	*0.17*	*ns*	*ns*	*ns*	-

**(0=nil damage, 5=all seminal roots with spear tips) ** (average of two strips)*

What does this mean?

In 2014 the exceptional start to the season resulted in early seeding, good crop establishment and early growth. The farmer demonstrations were all sown early, with the latest being the Piednippie barley on 20 May. The broad acre farmer demonstrations in the 2014 season showed no visual or differences in early plant growth measured at the given sites during the cropping season. There were differences in crown root numbers and % crown root infection at Cleve with the Nil treatment having higher numbers of both. There were differences at Piednippie in the barley crop sown mid-May, in Rhizoctonia patch score and the seminal root score which was later than the other crops included in the demonstrations.

In the 2014 season there were no significant yield advantages in the small plot header yields when using the fungicide products over the Nil treatments, but this was at sites with high Rhizoctonia inoculum levels, and in a season with an early start and minimal stress during crop establishment. There were differences in protein, screenings and test weights with a general trend of lower yields having higher protein, higher screenings and lower test weights. Further evaluation of research trials and farmer demonstrations using new fluid products and fungicide placement, will occur over two more seasons to evaluate the economics of using fungicides in low rainfall farming systems.

Acknowledgements

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Raxil and EverGol Prime - registered trademarks of the Bayer Group. Uniform and Vibrance - registered trademark of a Syngenta Group Company. Agriphar Experimental product of Agriphar Crop Solutions. Intake Hiload Gold registered trademark of Cropcare.

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Fluid delivery systems in canola

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RESEARCH

Searching for answers

Location:
Coulta, Morgan family
Rainfall
Av. Annual: 525 mm
Av. GSR: 465 mm
2014 Total: 499 mm
2014 GSR: 421 mm
Yield
Potential: 4.8 t/ha (C)
Actual: 1.2 t/ha
Paddock History
2014: CL canola
2013: Justica wheat
2012: Medic pasture
Soil Type
Grey loamy clay
Plot Size
20m x 2m x 3 reps

Key messages

- **This season showed no trace element differences given different delivery methods of granular, fluid or foliar application.**
- **The type of fertiliser used, fluid or granular, showed no differences in yield this season.**
- **There was no difference in yield, dry matter or disease with the addition of trace elements with fungicide treatments.**
- **The fungicide treatments combined did increase yield over the nil control treatment at this site, however the difference in blackleg disease levels scored was not significant.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. The fluid systems have the potential to increase production through delivery of micro and macro nutrients, reduce cost of trace element delivery, and increase control of cereal and canola root and leaf disease, resulting in possible increases in dry matter production and grain yield.

Blackleg continues to be a major issue facing canola growers especially on lower Eyre Peninsula and fluid delivery systems for product delivery may increase production and improve disease control. With the relatively recent development of processes to evenly coat fertiliser granules with fungicides and to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products.

How was it done?

A replicated canola fluid delivery trial was established at Coulta, sown with Clearfield 45Y86CL (CL canola) at 3 kg/ha. PreDictaB disease inoculum levels (RDTS), plant establishment, dry matter, blackleg infection, grain yield and quality were measured during the season.

The control fertiliser treatment was 100 kg/ha of 18:20:0:0. A fluid fertiliser delivery system placed fluid fertiliser approximately 3 cm below the seed at an output rate of 100 L/ha. The fluid fertiliser treatments were equivalent to 100 kg/ha of 18:20:0:0 as phosphoric acid and granular urea banded below the seed.

Manganese (Mn) was selected as the focus trace element in the nutrition trial, with zinc (Zn) and copper (Cu) also included in the trace element mix. The rate of Mn was 1.5 kg/ha as the standard rate as manganese sulphate, 1 kg/ha Zn as zinc sulphate and 0.2 kg/ha Cu as copper sulphate. Trace elements were also delivered as foliar applications at 4-5 leaf stage, and also at a half rate. Fungicides Jockey and Intake were included for blackleg disease control.

Weed control was applied broad acre on 20 June with Intervix @ 500 ml/ha and Select @ 500 ml with 5% uptake. On 3 July 120 kg/ha of sulphate of ammonia was applied broad acre and 100 kg/ha of urea on 25 July. The trial was harvested on 11 November 2014.

Data were analysed using Analysis of Variance in GENSTAT version 16, and also with an unbalanced design used for the main effects.

What happened?

The soil was shallow with limestone below and due to the direction of seeding and the knife points used on the plot seeder, some rocks were pulled up which resulted in uneven plots. However there were no significant differences in plant establishment counts within the trial (data not shown) with the average plant establishment being 41 plants/m^2. There were no differences in early dry matter, yield or grain quality measurements recorded this season in the trial (Table 1). The reduction in phosphorus fertiliser with the urea only and half rate of phosphoric acid reduced yield by 0.5 t/ha (Table 1).

Plants were tested for Beet Western Yellows virus but the test was negative at this site. Plant tissue tests (youngest leaf) were analysed at late cabbage stage which showed no trace element deficiencies at this site.

Table 1 Growth measurements (dry matter), yield and grain quality for CL canola in Coulta trial, 2014

Treatment	Early dry matter (g/plant)	Yield (t/ha)	Oil (%)	Protein (%)
Phos acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	0.12	1.49	42.5	21.0
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	0.10	1.33	42.8	20.9
APP and UAN	0.10	1.33	43	21.0
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.07	1.31	43.4	21.3
Control	0.07	1.27	43.1	20.6
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.10	1.25	43.3	20.7
Phos acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	0.10	1.24	42.8	21.2
Control	0.10	1.22	42.7	20.8
Phos acid and 3 kg/ha $MnSO_4$ liquid and Gran Urea	0.08	1.22	43	20.9
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.06	1.20	42.7	21.0
Phos acid and urea (equivalent 100 kg/ha DAP)	0.08	1.17	43	20.8
DAP and Foliar Mn @ 1.5 kg/ha	0.07	1.14	42.6	20.7
DAP with Mn coated fertiliser 1.5 kg/ha	0.08	1.09	42.1	21.3
Urea only	0.05	0.99	42.8	20.8
Half rate Phos acid (equivalent 50 kg/ha DAP) and urea	0.10	0.94	42.4	21.1
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*

Disease

Table 2 Yield of CL canola with different nutrition treatments at Coulta trial, 2014

Fertiliser source	Yield (t/ha)
APP and UAN	1.32
Control	1.24
Phosphoric acid	1.21
Granular fertiliser	1.20
Urea only	0.99
LSD (P=0.05)	*ns*

Table 3 Disease scores, growth measurements and yield for CL canola with fungicides and nutrition treatments at Coulta trial, 2014

Nutrition treatment	Late dry matter (kg/plant)	Blackleg score (% infection)	Yield (t/ha)
Zn, Cu, Mn with fungicide	0.68	25	1.22
Mn with fungicide	0.92	27	1.16
No TE with fungicide	0.79	34	1.14
Control	0.72	33	0.99
LSD (P=0.05)	*ns*	*ns*	*ns*

Table 4 Disease scores, growth measurements and yield for CL canola with fungicide treatments at Coulta trial, 2014

Fungicide treatment	Late dry matter (kg/plant)	Blackleg score (% infection)	Yield (t/ha)
Intake and Jockey	0.82	12	1.63 a
Intake	0.67	28	1.30 ab
Jockey	0.75	29	1.05 b
Control	0.72	33	0.99 b
LSD (P=0.05)	*ns*	*ns*	*0.35*

There were no significant differences at this site using different fertilisers types, granular or fluid; APP and UAN, phosphoric acid, granular DAP or urea only (Table 2). There were no differences recorded in early dry matter or grain quality given the different fertiliser treatments and applications.

In the trial this season there were no differences in plant growth, disease or yield given nil or different trace elements mixes applied this season (Table 3). The treatment with both fungicides applied did increase yield over the nil treatment at this site (Table 4), which is supported by previous research in this region but there were no significant differences in the blackleg disease scores in the trial. There were no differences in plant establishment or grain quality depending on the fungicide and nutrition treatment applied (data not shown; protein (average 20.9%), oil (average 42.8%)).

What does this mean?

The initial season at this site has showed no response to trace elements using different delivery methods, of granular, fluid or foliar application on canola. The type of fertiliser used, fluid or granular showed no differences in yield this season, however the lower phosphorus and urea only treatments had lower yields indicating a phosphorus response at the site. This is the first year of this research and it will be repeated over another two seasons.

There was no difference in dry matter or disease with the addition of trace elements or fungicide treatments. The fungicide treatments when combined did significantly increase yield over the nil fungicide control treatment at this site, however the difference in blackleg disease levels scored was not significant. The combined effect of fungicides giving additional protection has been reported in other research in this area, and the early protection of plants is important to reduce blackleg infection early due to rain splash.

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SAGIT

Fluid delivery systems and fungicides in wheat at Warramboo and Streaky Bay

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RESEARCH

Searching for answers

Location: Warramboo
Darren Sampson and family
Rainfall
Av. Annual: 313 mm
Av. GSR: 227 mm
2014 Total: 302 mm
2014 GSR: 190 mm
Yield
Potential yield: 2.1 t/ha (W)
Actual: 2.0 t/ha
Paddock History
2014: Wheat
2013: Wheat
Soil Type
Red sandy loam
Plot Size
20m x 2m 3 reps

Location: Streaky Bay
Luke Kelsh and family
Rainfall
Av. Annual: 379 mm
Av. GSR: 304 mm
2014 Total: 441 mm
2014 GSR: 227 mm
Yield
Potential yield: 3.8 t/ha (W)
Actual: 1.0 t/ha
Paddock History
2014: Wheat
2013: Medic pasture
Soil Type
Grey calcareous sandy loam
Plot Size
20m x 2m x 3 reps

Key messages

- **2014 trial results showed using phosphoric acid as the phosphorus source compared to granular fertiliser produced a significant response in early dry matter and a 0.13 t/ha yield increase on highly calcareous soil at Streaky Bay.**
- **Zinc deficiency was present at mid tillering at Streaky Bay but it was corrected with the trace element treatment.**
- **There were no differences to grain yield as a result of fungicide applications or rates at Streaky Bay which had a high Rhizoctonia inoculum level.**
- **There were no differences in yield given differing nutrition applications at Warramboo, with DAP and trace elements or phosphoric acid and manganese performing similar.**
- **The Warramboo site had medium Rhizoctonia inoculum levels and low disease expression, however there were differences in late dry matter and yield with trace element plus fungicide applications, but there were no differences between fungicide placement or rates.**
- **Research into fluid delivery for nutrition and fungicides will continue for another two seasons.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrients and disease control strategies in current farming systems. The fluid systems (fertilisers or nutrients) have the potential to increase production through delivery of micro and macro nutrients, reduce cost of trace element delivery, and increase control of cereal root and leaf disease, resulting in possible increases in dry matter production and grain yield.

Historically, fungicidal control of Rhizoctonia which infects the major crops grown in southern Australia has generally been poor, but fluid delivery systems with fungicides are a new option of delivery which may increase production and improve disease control. With the relatively recent development of processes to evenly coat fertiliser granules with fungicides and to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products. This trial was undertaken to assess the benefits of these products, and various application strategies, on wheat in two upper Eyre Peninsula environments.

How was it done?

Two identical replicated trials were established at Warramboo on a red sandy soil and Streaky Bay on a grey calcareous soil in 2014. Both trials were divided into 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 fungicide fluid system could also be split to delivery fluids both below the seed at approximately 3 cm, and above in the seeder furrow behind the press wheel in a 1 cm band.

The control treatment was 60 kg/ha of Mace wheat with 50 kg/ha of 18:20:0:0 (DAP). Manganese (Mn) was selected as the main focus trace element, with zinc (Zn) and copper (Cu) also included in the trace element mix. A DAP fertiliser blend with Mn @ 1.5 kg/ha was sourced. Phosphoric acid and granular urea, and 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 standard rate being 1.5 kg/ha, with 0.8 kg/ha as the low rate and 3 kg/ha as a high rate. 1 kg/ha Zn, as zinc sulphate and 0.2 Cu of copper sulphate were dissolved in the standard rates of trace elements and half these products as the low rate.

Trace elements were also delivered as foliar applications at 4-5 leaf stage, and also a half foliar rate.

The fungicides Uniform (SYNSIF1 in furrow), EverGol Prime and Vibrance (seed dressings) were assessed for Rhizoctonia disease suppression with trace elements, at different rates and in split applications.

The Warramboo trial was sown on 16 May with pre-sowing weed control of 1.5 L/ha Roundup Power max Extra, 1.5 L trifluralin, 80 ml/ha Hammer and a wetter. In crop weed control was on 31 July with 700 ml/ha Amicide 700.

The Streaky Bay trial was sown in slightly drier conditions on 20 May with pre-sowing weed control using 1 L/ha Roundup Power max Extra, 1 L/ha trifluralin and 80 ml/ha Hammer, before a 20 mm rainfall event. It was sprayed on June 16 with 25 ml/ha of Karate for slight insect damage. In crop weed control for ryegrass and small medic was applied on 28 July with 430 g/ha Achieve, 60 ml/ha Lontrel Advance and wetter.

PreDictaB disease inoculum levels (RDTS), plant establishment, Rhizoctonia seminal root score, Rhizoctonia crown root score, green leaf area index, grain yield and quality were measured during the season.

Rhizoctonia infection on seminal roots and crown roots was assessed using the root scoring method described by McDonald and Rovira (1983) eight weeks from seeding, on 18 July at Warramboo and 21 July at Streaky Bay. 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 on 12 November at Warramboo, and harvest started on 17 November at Streaky Bay, but finished on the 21 November due to a header breakdown. Selected reps were sampled for harvest soil moistures.

Data were analysed using Analysis of Variance in GENSTAT version 16.

What happened?

At Warramboo the initial Predicta B inoculum level predicted a medium risk of Rhizoctonia disease (51 pgDNA/g soil). The Take-all level was high but there were low levels of inoculum for other soil borne diseases. Plant establishment at Warramboo was the same for all treatments, with an average of 124 plants/m^2 in the fluid nutrition trial and 100 plants/m^2 in the fungicide trial.

The initial Predicta B inoculum level at Streaky Bay predicted a high risk of Rhizoctonia disease (745 pgDNA/g soil) and there were low levels of inoculum for all other soil borne diseases. There were no differences in plant establishment with an average of 125 plants/m^2 in wheat in the fluid nutrition trial and 118 plants/m^2 in the fungicide trial.

The 2014 season had late summer and good autumn rains with adequate soil moisture and early sowing in most areas compared to the average sowing date. These conditions provided lush early crop growth as plants were not as limited as by moisture and the increased availability of nutrition, especially nitrogen and phosphorus, enabling greater root growth. This allowed the plants to grow through the impact of Rhizoctonia root infection, especially at the Warramboo site.

Drier conditions at seeding and only spraying the green bridge out just before sowing as well as a high inoculum level resulted in Rhizoctonia patches being present in the Streaky Bay trial. The trial at Warramboo had less Rhizoctonia disease pressure and was generally even all season except the urea only treatment, which had less growth.

At the Warramboo site there was a low level of Rhizoctonia inoculum present and generally the trial was even with little disease expression. There were no 'stand out' treatments during the season, however the urea only treatment looked poor all season. There were no differences at Warramboo in the nutrition trial in early dry matter or yield measurements recorded this season, however the DAP and liquid trace element mix was the highest yielding (Table 1). Grain quality showed no differences with the trial averages being test weight of 81.4 (kg/hL), protein 9.9%, screenings 2.2% and 1000 grain weight of 37.8 g (data not presented).

The fungicide trial at Warramboo had no differences in early dry matter or Rhizoctonia root assessment taken at eight weeks (Table 2). There were differences in late dry matter and grain yield with some fungicide treatments plus trace elements mix having higher dry matter and yield (Table 2). The split application of fungicides in furrow did not perform better than fungicide in furrow below the seed, seed dressing or fertiliser application at this site in the 2014 season. Grain quality showed no differences with the trial averages being test weight of 79.8 (kg/hL), protein 10.0%, screenings 2.9% and 1000 grain weight of 36.6 g (data not presented).

Table 1 Fluid delivery of nutrition trial growth measurements (dry matter), yield and grain quality for Mace wheat at Warramboo, 2014

Treatment	Early DM (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late DM (kg/m^2)	Yield (t/ha)
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	17.8	3.0	47.3	1.6	2.13
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	19.2	2.9	42.4	1.3	2.11
Phosphoric acid and 3kg/ha MnSO4 liquid and Gran Urea	19.3	3.0	39.4	1.5	2.07
Phosphoric acid and urea (equivalent 50 kg/ha DAP)	16.0	2.9	36.8	1.3	2.05
Phosphoric acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	17.1	2.9	39.1	1.4	2.03
DAP and Foliar Mn @ 1.5 kg/ha	18.9	3.0	45	1.3	1.98
Half rate Phosphoric acid (equivalent 25 kg/ha DAP) and urea	16.2	2.9	45.6	1.3	1.97
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	15.5	2.9	42.0	1.2	1.96
Control	17.7	2.9	38.7	1.4	1.95
Control	16.6	2.9	33.9	1.2	1.95
APP and UAN (equivalent 50 kg/ha DAP)	18.3	2.8	40.3	1.3	1.94
DAP with Mn coated fertiliser 1.5 kg/ha	19.5	2.9	40.5	1.3	1.90
Phos acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	15.9	2.8	40.8	1.3	1.90
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	15.5	2.8	33.9	1.3	1.89
Urea only	12.9	3.0	39.0	1.1	1.74
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*

The trial at Streaky Bay was very uneven and had patchy growth due to a high initial inoculum level and Rhizoctonia disease expression. The fungicide trial was visually more even in growth earlier in the season than the nutrition trial but Rhizoctonia patches were still present. There were no treatments which were visually better in the trial. There were differences in the early dry matter in the nutrition treatment on the grey calcareous soil with most phosphoric acid with granular urea treatments having better early growth at 8 weeks. The tissue test taken at mid tillering showed some zinc deficiency at this site, with the trace element treatments having adequate levels.

There were no differences at Streaky Bay in nutrition in yield measurements recorded this season in the trial, however the phosphoric acid treatments with manganese were highest yielding (Table 3). Grain quality showed no differences with the trial averages being test weight of 80.2 (kg/hL), protein 10.3%, screenings 1.6% and 1000 grain weight of 39.7 g (data not presented).

There were no differences at Streaky Bay in fungicide in dry matter, Rhizoctonia root scores, yield or quality measurements recorded this season in the trial (Table 4). Grain quality averages of the trial were, test weight of 80.7 (kg/hL), protein 10.0 %, screenings 1.7 % and 1000 grain weight of 40.4 g (data not presented).

Table 2 Disease scores, growth measurements and yield for fungicides in Mace wheat at Warramboo trial, 2014

Treatment	Fertiliser	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
Uniform @ 300 ml/ha – split application	DAP and Liquid Trace elements (Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha)	17.8	2.6	42.3	1.45	2.24[a]
Fungicide in furrow low	DAP and TE	15.4	2.8	48.1	1.58	2.24[a]
Uniform @ 150 ml/ha – split application	DAP and TE	22.8	2.6	49.6	1.48	2.21[a]
Uniform @ 300 ml/ha on fertiliser	DAP and TE	19.5	2.6	43.8	1.42	2.19[ab]
Uniform @ 300 ml/ha and Vibrance seed dressing @ 300 ml/100 kg seed	DAP and TE	20.0	2.6	38.0	1.44	2.18[abc]
Uniform @ 300 ml/ha	DAP	19.9	2.7	45.8	1.46	2.15[abcd]
Uniform @ 150 ml/ha	DAP and TE	16.9	2.6	49.1	1.59	2.12[abcd]
Fungicide in furrow low	DAP	16.8	2.6	48.9	1.46	2.12[abcd]
EverGol Prime seed dressing @ 80ml/100 kg seed	DAP and TE	16.9	2.6	49.9	1.26	2.12[abcd]
Uniform @ 300 ml/ha – split application	Mn only @ 1.5 kg/ha	17.5	2.4	44.4	1.17	2.12[abcd]
Control	DAP	18.1	2.8	57.9	1.17	2.10[abcd]
Fungicide in furrow high	DAP and TE	14.3	2.7	43.6	1.47	2.05[bcd]
Control	DAP	17.1	2.6	54.9	1.22	2.00[bcd]
Uniform @ 300 ml/ha	DAP and TE	17.5	2.5	53.0	1.36	2.04[cd]
Uniform @ 300 ml/ha – split application	DAP	15.6	2.8	45.0	1.26	2.03[cd]
Uniform @ 150 ml/ha and Vibrance seed dressing @ 150 ml/100 kg seed	DAP and TE	15.2	2.4	40.1	1.43	2.02[d]
LSD (P=0.05)		*ns*	*ns*	*ns*	*0.075*	*0.15*

The analysis of the main effects of the trials at Warramboo and Streaky Bay showed no differences in the treatments except the use of phosphoric fertiliser at Streaky Bay which resulted in a 0.13 t/ha increase in yield over the standard practice of using granular DAP fertiliser.

What does this mean?

In the 2014 season all nutrition treatments at Warramboo performed similarly, except the urea only treatment which was poor all season, but the DAP or phosphoric acid and trace element mixes performed best in both the nutrition and fungicide trial at this site. There were no nutritional differences detected in mid-tillering tissue tests.

The Warramboo site had medium Rhizoctonia inoculum levels and low disease expression and there were no differences in root disease assessment of seminal or crown roots at 8 weeks. There were differences in late dry matter and yield due to fungicide treatments plus trace elements mixes having higher dry matter and yield. The application method of the fungicides; split in furrow, in furrow below the seed, seed dressing or fertiliser application, were not different at this site in this season and higher rates did not perform better than lower rates.

Table 3 Fluid delivery of nutrition trial growth measurements, yield and grain quality for Mace wheat at Streaky Bay, 2014

Treatment	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
Phosphoric acid and 3 kg/ha $MnSO_4$ liquid and Gran Urea	0.20 a	3.4	82.6	0.61	1.15
Phosphoric acid and 0.8 kg/ha $MnSO_4$ liquid and Gran Urea	0.17 ab	3.3	73.7	0.59	1.15
Control	0.13 bc	3.5	80.2	0.38	0.98
Half rate Phosphoric acid (equivalent 25 kg/ha DAP) and urea	0.16 abc	3.3	87.1	0.3	0.98
DAP and Foliar Mn @ 1.5 kg/ha	0.13 bc	3.5	86.1	0.53	0.97
APP, UAN and liquid TE Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.11 c	3.3	85.2	0.37	0.95
Phosphoric acid and 1.5 kg/ha $MnSO_4$ liquid and Gran Urea	0.16 abc	3.2	84.3	0.50	0.94
Urea only	0.14 bc	3.4	79.6	0.43	0.91
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.12 c	3.5	83.5	0.48	0.91
DAP with Mn coated fertiliser 1.5 kg/ha	0.13 bc	3.3	93.0	0.41	0.90
DAP and half rate Foliar Trace elements (4-5 leaf stage) Mn @ 0.8 kg/ha, Zn @ 0.5 kg/ha, Cu @0.1 kg/ha	0.13 bc	3.5	86.1	0.66	0.90
Control	0.11 c	3.3	82.2	0.48	0.88
Phosphoric acid and urea (equivalent 50 kg/ha DAP)	0.13 bc	3.4	81.9	0.40	0.88
APP and UAN (equivalent 50 kg/ha DAP)	0.14 bc	3.3	85.4	0.70	0.88
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha	0.12 c	3.5	85.4	0.62	0.79
LSD (P=0.05)	*0.05*	*ns*	*ns*	*ns*	*ns*

Table 5 Analysis of main treatments in unbalanced design at Warramboo and Streaky Bay, 2014

Fluid delivery - Fertiliser	Warramboo yield (t/ha)	Streaky Bay yield (t/ha)
DAP	2.00	0.90 b
Phosphoric acid	2.01	1.03 a
APP	1.92	0.91 ab
LSD (P=0.05)	*ns*	*0.13*
Fluid delivery - Fungicide	**Warramboo yield (t/ha)**	**Streaky Bay yield (t/ha)**
Control	2.15	0.94
Uniform	2.12	0.89
EverGol Prime	2.11	0.93
LSD (P=0.05)	*ns*	*ns*

Table 4 Disease scores, growth measurements and yield for fungicides in Mace wheat at Streaky Bay trial, 2014

Treatment	Fertiliser	Early dry matter (g/plant)	Seminal root score (0-5)	Crown Root Infection (%)	Late dry matter (kg/m^2)	Yield (t/ha)
EverGol Prime seed dressing @ 80 ml/100 kg seed	DAP and Liquid Trace elements (Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha)	0.17	3.1	76.6	0.58	1.00
Uniform @ 150 ml/ha	DAP and TE	0.19	3.2	78.4	0.49	0.98
Uniform @ 300 ml/ha – split application	DAP and TE	0.17	2.9	74.3	0.49	0.98
Uniform @ 150 ml/ha and Vibrance seed dressing @ 150 ml/100 kg seed	DAP and TE	0.19	2.9	78.7	0.54	0.97
Fungicide in furrow low	DAP and TE	0.18	3.1	75.7	0.66	0.97
Fungicide in furrow high	DAP and TE	0.18	3.0	80.1	0.52	0.94
Uniform @ 150 ml/ha – split application	DAP and TE	0.18	3.1	78.4	0.49	0.92
Control	DAP	0.19	3.3	85.3	0.5	0.91
Uniform @ 300 ml/ha – split application	Mn only @ 1.5 kg/ha	0.15	3.0	82.5	0.53	0.91
Uniform @ 300 ml/ha and Vibrance seed dressing @ 300 ml/100 kg seed	DAP and TE	0.18	2.9	67.8	0.64	0.90
Uniform @ 300 ml/ha	DAP and TE	0.18	3.1	75.5	0.53	0.88
Uniform @ 300 ml/ha – split application	DAP	0.16	3.0	75.1	0.56	0.88
Uniform @ 300 ml/ha	DAP	0.16	3.0	76.6	0.47	0.86
Fungicide in furrow high	DAP	0.16	3.2	81.9	0.39	0.80
Control	DAP	0.14	3.2	88.6	0.45	0.77
Uniform @ 300 ml/ha on fertiliser	DAP and TE	0.12	3.2	85.8	0.38	0.75
LSD (P=0.05)		*ns*	*ns*	*ns*	*ns*	*ns*

The Streaky Bay trial showed a 0.13 t/ha yield increase over 18:20:0:0 using phosphoric acid as the phosphorus source. There were also differences in the early dry matter with phosphoric acid with manganese with granular urea treatments having greater early growth. The tissue tests taken at mid tillering indicated zinc deficiency in some treatments at Streaky Bay, but it was corrected with the trace element treatment. Manganese deficiency was not detected at this site in tissue tests, despite the treatments with added manganese having better early growth. There were no significant differences in fungicide treatments, application method or rates at this site, but treatments will be included next season with phosphoric acid, trace elements and fungicide mixes.

These trials will continue for another two seasons to have a better understanding of the best fertiliser mixes and fungicide applications and to increase confidence in fluid delivery systems.

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SAGIT

Disease

Fluid delivery systems in canola

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SARDI, Minnipa Agricultural Centre

RESEARCH

Searching for answers

Location:
Coulta
Morgan family
Rainfall
Av. Annual: 525 mm
Av. GSR: 465 mm
2015 Total: 397 mm
2015 GSR: 350 mm
Yield
Potential: 3.6 t/ha (C)
Actual: 2.0 t/ha
Paddock History
2015: CL Canola
2014: Barley
2013: Wheat
Soil Type
Grey loamy sand
Plot Size
20 m x 2 m x 3 reps

Key messages

- **There were no differences in canola Blackleg infection or yield using fungicides as seed treatments or in-furrow in 2015.**
- **In 2014 combined protection of a fungicide on seed and in the furrow as a banded fluid reduced Blackleg infection and increased yield.**
- **The selection of Blackleg resistant varieties in the rotation is important.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. The fluid systems have the potential to increase production through delivery of micro and macro nutrients, lower cost of trace element delivery and better control of cereal and canola root and leaf diseases.

Blackleg continues to be a major issue facing canola growers especially on lower Eyre Peninsula and fluid delivery systems for product delivery may increase production and improve disease control. With the development of fungicides and the ability to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products. Two trials separately investigated the relative benefits of a range of fungicide strategies for Blackleg control and a range of manganese (Mn) delivery options on canola yield. The performance of fluid phosphorus was also tested.

How was it done?

In autumn 2014, a national trial was set up to examine sampling position and stubble addition effect on crown rot detection. Four separate soil samples were collected from each of 129 NVT sites. At each site, two samples were collected on the row and two between the rows of the previous cereal crop. For each sampling position, one sample was supplemented with 15 pieces of cereal or grass weed stubble about 5 cm long (one piece by 15 locations) and the other was not. Samples were analysed using the PreDicta B DNA test.

What happened?

In the 2015 the trials were split, with the Blackleg trial located at Coulta and the nutrition trial focusing on manganese located at Farm Beach. Both replicated trials were sown with Clearfield 45Y86CL (CL canola) at 3 kg/ha. PreDictaB disease inoculum levels (RDTS), plant establishment, Blackleg infection and grain yield were measured during the season.

For the Blackleg trial the fertiliser treatment was 100 kg/ha of 18:20:0:0 with in furrow fungicides or trace elements delivered as a fluid. The trace element treatment had Mn at 1.5 kg/ha of manganese sulphate, 1 kg/ha Zn as zinc sulphate and 0.2 kg/ha Cu as copper delivered at a water rate of 80 L/ha. The fungicides Jockey and Intake were evaluated for Blackleg disease control. The paddock was spread with 500 kg/ha of gypsum in mid-April. The paddock was sprayed with 2.5 L/ha Roundup Attack with 2% LI700, 1.5 L/ha TriflurX, 100 ml/ha Goal, 40 g/ha Sentry and 290 ml/ha Lorsban with an 80 L/ha water rate. The trial was sown on 14 May.

Weed control was applied broad acre on 20 June with Targa @ 500 ml and Select @ 500 ml with 5% uptake at 100 L/ha water rate. 90 kg/ha of urea was applied broad acre on 25 June and also on 13 July. The fungicide trial was desiccated on 2 November with Sprayseed 250 @ 4 L/ha and harvested on 16 November 2015.

The Mn trial was not harvested because of very poor establishment, a dry finish and extensive bird damage near maturity which made fair comparisons between treatments impossible. Only results from the Coulta Blackleg trial are reported.

Data were analysed using Analysis of Variance in GENSTAT version 16.

Fungicide treatment	Canola establishment (plants/m²)	Blackleg score (% infection)	Yield (t/ha)
Intake (in furrow) and Jockey (on seed)	32.7	10.2	2.18
Intake (in furrow)	35.0	11.1	2.01
Intake (on fertiliser)	38.6	15.1	2.08
Jockey (seed)	39.9	22.4	1.87
Control	29.7	12.6	2.09
Control plus Trace elements	30.1	19.8	2.11
LSD (P=0.05)	*ns*	*ns*	*ns*

Table 1 Disease scores, growth measurements and yield for CL canola with fungicide treatments in Coulta trial, 2015.

What happened?

The fungicide trial was located at Coulta within an intensive canola cropping region with a potentially high Blackleg disease pressure. A PredictaB test showed high disease risk for Rhizoctonia but low risk levels for *Pratylenchus neglectus*.

The initial soil data showed adequate soil nutrition, phosphorus and trace elements at the trial site with 71 mm of soil moisture in the plant root zone.

Establishment was unaffected by fungicide treatments, averaging 34 plants/m² (Table 1). The Blackleg infection was lower in 2015 (av. 15%) compared to 2014 (av. 29%). There were no significant differences in Blackleg infection due to the fungicide treatments imposed as seed dressings or in furrow recorded at this site in 2015. There were no differences in yield recorded in 2015 (Table 1).

What does this mean?

In the 2014 season in the same trial the combined fungicide treatments did significantly increase yield over the nil fungicide control treatment at a similar site, however the difference in Blackleg disease levels scored was not significant (EPFS Summary 2014, Fluid delivery systems in canola, p104).

In 2015 there were no significant differences in Blackleg infection or yield at this site. The selection of resistant varieties with high Blackleg ratings within paddock rotations is important.

Acknowledgements

Thank you to the Morgan family for having the trial on their property, and Terry Blacker and Ashley Flint for help with these trials. Trial funded by SAGIT Improving fertiliser efficiency and reducing disease impacts using fluid delivery systems, S614.

Registered products: see chemical trademark list.

Fluid delivery systems and fungicides in wheat

RESEARCH

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Searching for answers

Location:
Warramboo
Darren Sampson and family
Rainfall
Av. Annual: 313 mm
Av. GSR: 227 mm
2015 Total: 326 mm
2015 GSR: 237 mm
Yield:
Potential: 3.2 t/ha
Actual: 3.0 t/ha
Paddock History
2015: Mace wheat
2014: Mace wheat
2013: Medic pasture
Soil Type
Red sandy loam
Plot size
20 m x 2 m x 3 reps

Location:
Streaky Bay
Luke Kelsh and family
Rainfall
Av. Annual: 379 mm
Av. GSR: 304 mm
2015 Total: 249 mm
2015 GSR: 212 mm
Yield:
Potential: 2.0 t/ha (W)
Actual: 1.2 t/ha
Paddock History
2015: Mace wheat
2014: Medic pasture
2013: Mace wheat
Soil Type
Grey calcareous sandy loam
Plot size
20 m x 2 m x 3 reps

Key messages

- **Phosphoric acid showed a yield response at Streaky Bay in 2014 of 13% and 2015 of 8%.**
- **Fungicides did not reduce Rhizoctonia infection or significantly increase yield in 2015 at either site despite high levels of inoculum.**
- **Including fungicides will increase input cost and risk over a cropping program.**
- **The addition of trace element or manganese treatments did not improve yield at Streaky Bay or Warramboo in 2015.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrients and disease control strategies in current farming systems. The fluid systems (fertilisers or nutrients) have the potential to increase production through delivery of micro and macro nutrients, reduce cost of trace element delivery and increase control of cereal root and leaf disease.

Historically, fungicidal control of Rhizoctonia, which infects the major crops grown in southern Australia, has generally been poor, but fluid delivery systems with fungicides are a new option of delivery which may increase production and improve disease control. This trial was undertaken to assess the benefits of delivery of nutrients and these products, and various application strategies, on wheat in two upper Eyre Peninsula environments.

How was it done?

Three replicated trials were established, one at Warramboo on a red sandy soil and two at Streaky Bay on a grey calcareous sand in 2015. At Streaky Bay the nutrition and fungicide treatments were split into two smaller trials located behind each other due to the site variations with hills and shallow soil. Both trials 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 fungicide fluid system could also be split to deliver fluids both below the seed at approximately 3 cm, and above in the seeder furrow behind the press wheel in a 1 cm band.

The control treatment 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 units of phosphorus (P) and balanced with urea or UAN to 10 units of nitrogen (N). Manganese (Mn) was selected as the main focus trace element, with zinc (Zn) and copper (Cu) also included in the trace element mix. A DAP fertiliser dry blend with Mn @ 1.5 kg/ha was sourced. Phosphoric acid and granular urea, and 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 standard rate being 1.5 kg/ha and 3 kg/ha as a high rate. 1 kg/ha Zn, as zinc sulphate and 0.2 Cu of copper sulphate were dissolved in the standard rates of trace elements, which were also delivered as foliar applications at 4-5 leaf stage.

The fungicides Uniform, EverGol, Vibrance (seed dressing) were assessed for Rhizoctonia disease suppression at different rates and in split applications. Triadimenol was also applied on fertiliser as a treatment.

The Warramboo trial was sown on 19 May with pre-sowing weed control of 1.5 L/ha Roundup Attack, 1.5 L Boxer Gold and 80 ml/ha Nail. In crop weed control was on 31 July with 1.2 L/ha of Broadside, later than ideal due to the sampling required on the trial. Urea was spread over the whole trial on 31 July at 20 kg/ha.

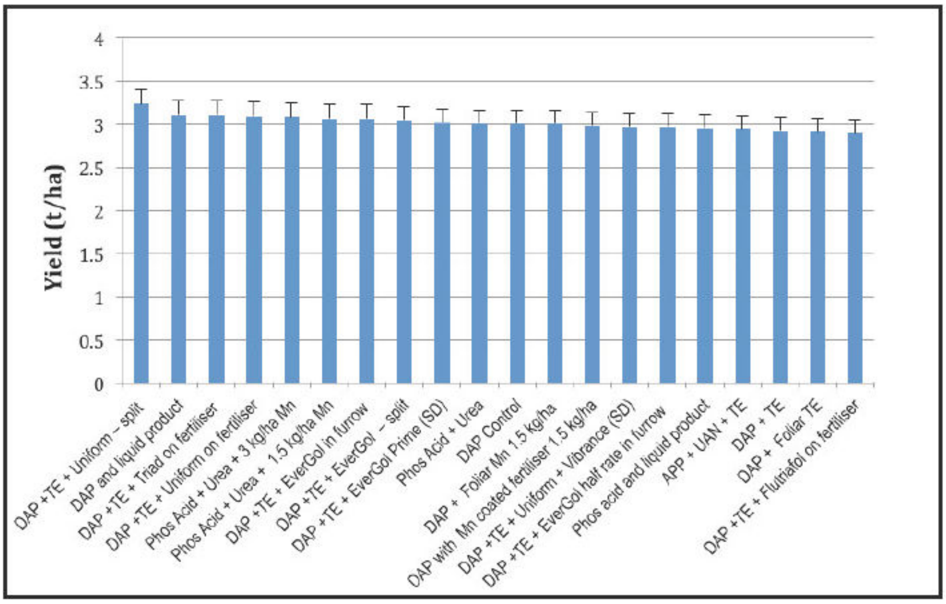

Figure 1 Yield for Mace wheat with fertiliser and fungicide treatments at Warramboo trial, 2015 (non-significant).

The Streaky Bay trial was sown in dry conditions on 28 May with pre-sowing weed control using 1.5 L/ha Roundup Attack, 1.5 L Boxer Gold and 100 ml/ha Nail. It was sprayed on 11 July with 240 ml/ha of Dominex Duo for insect control. The trace element foliar treatments were applied at Zadocks growth stage 22 on 14 August. In crop weed control was on 3 September with 1.5 L/ha of Amicide 700 to control Lincoln weed (*Diplotaxis tenuifolia*) and sheep weed (*Lithospernum avensis*).

PreDictaB disease inoculum levels (RDTS), plant establishment, Rhizoctonia seminal root score, Rhizoctonia crown root score, green leaf area index, grain yield and quality were measured during the season.

Rhizoctonia infection on seminal roots and crown roots was assessed using the root scoring method described by McDonald and Rovira (1983) approximately seven weeks from seeding, on 13 July at Warramboo and 20 August at Streaky Bay. 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 on 16 November at Warramboo and 17 November at Streaky Bay. Data were analysed using Analysis of Variance in GENSTAT version 16.

What happened?

At both sites, the initial Predicta B inoculum level predicted a high risk of Rhizoctonia disease (Warramboo 150 pg DNA/g soil, Streaky Bay 208 pg DNA/g soil), Take-all and *Pratylenchus neglectus* were low risk. Warramboo also had low levels of Cereal Cyst Nematode.

Both sites have alkaline pH, reasonable soil phosphorus levels and adequate nutrient levels (data not presented). Initial soil moisture levels were much lower at Streaky Bay than Warramboo. The main difference with these soil types from previous soil analyses are 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.

Plant establishment in ideal seeding conditions at Warramboo averaged 124 plants/m² but some fungicide treatments lowered plant establishment. In Streaky Bay the general plant establishment was poor due to the dry seeding conditions and not affected by treatments.

Rhizoctonia patches were present the Streaky Bay trial early in the season. The low soil moisture resulted in stressed plants and limited early plant growth. The trial at Warramboo had similar Rhizoctonia disease inoculum levels as Streaky Bay with some patches present in the trial area. The barley crop grown in the paddock showed significant Rhizoctonia disease symptoms.

There were no differences at Warramboo in dry matter or grain yield in fungicide and nutrition treatments, with treatments averaging 3.0 t/ha (Figure 1). Grain quality showed no differences with the trial averages being; test weight of 81.5 (kg/hL), protein 9.1%, screenings 1.3% (data not presented).

The fungicide treatments at Warramboo had Rhizoctonia infection on both seminal and crown roots however there were no significant differences between the fungicide treatments imposed on Rhizoctonia root assessment taken at eight weeks (data not presented). The application of fungicides in furrow did not perform better than fertiliser application or seed dressing at this site.

There were no significant differences in 2015 at Warramboo between the fungicide treatments (Figure 1), but there were small differences in fungicide treatments in 2014. The input costs (Table 1) of the treatments in the 2015 seasons at the Warramboo site shows the increased input cost over the control with higher risk over a whole cropping program. This soil type also showed no yield response to phosphorus or alternative phosphorus sources, highlighting the need for a responsive soil type before changing to a fluid fertiliser strategy for phosphorus.

Table 1 The input cost ($/ha) of the nutrition and fungicide treatments imposed at Warramboo in 2015.

Treatment	Variable costs* ($/ha)	P fertilser ($/ha)	Nitrogen +Trace Elements ($/ha)	Fungicide ($/ha)	Total Cost ($/ha)
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	99	38	15		152
Phosphoric acid and 3 kg/ha MnSO4 liquid and Gran Urea	99	43	26		168
Phosphoric acid and Gran urea (equivalent 50 kg/ha DAP)	99	43	23		165
Phosphoric acid and 1.5 kg/ha MnSO4 liquid and Gran Urea	99	43	24		166
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha	99	38	13		150
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	99	38	15		152
APP and UAN (equivalent 50 kg/ha DAP) and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	99	53	15		167
DAP with Mn coated fertiliser 1.5 kg/ha	99	38	13		150
Control DAP	99	38	11		148
DAP+TE Uniform @ 300 ml/ha Split IF	99	38	15	19	171
DAP+TE EverGol 80 ml/ha Split IF	99	38	11	9	157
DAP+TE Uniform on fertiliser @ 300 ml/ha	99	38	15	19	171
DAP+TE Uniform@300 ml/ha + Vibrance (SD)	99	38	15	25	177
DAP and TE EverGol 80 ml/ha IF	99	38	15	9	161
DAP and TE EverGol 40 ml/ha IF	99	38	15	4	156
DAP and TE EverGol (SD) 80 ml/100 kg seed	99	38	15	9	161

**Variable costs are seed, chemical, repairs and maintenance, fuel and crop insurance*

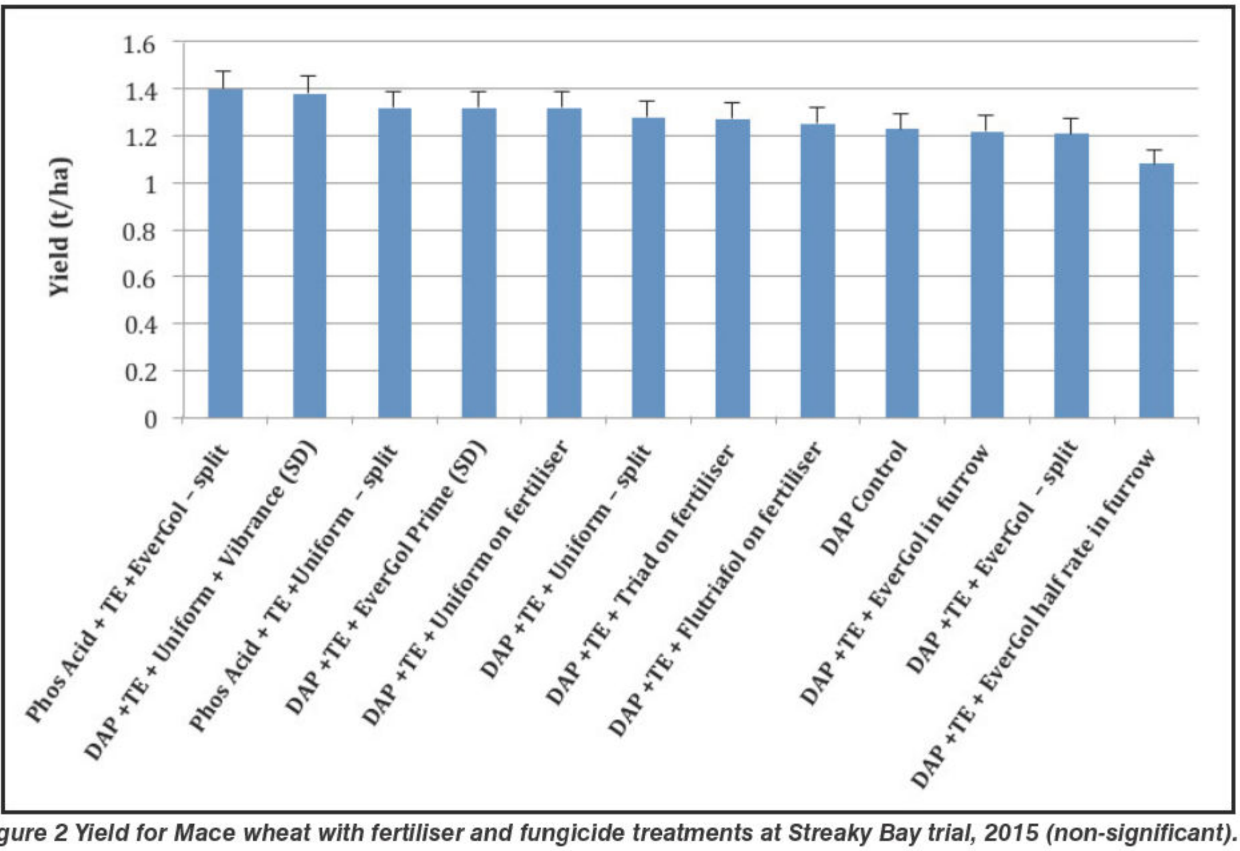

***Figure 2** Yield for Mace wheat with fertiliser and fungicide treatments at Streaky Bay trial, 2015 (non-significant).*

Table 2 Fluid delivery of nutrition trial growth measurements, yield and grain quality for Mace wheat at Streaky Bay, 2015.

Treatment	Plant establishment (plants/m²)	Early dry matter (g/plant)	Late dry matter (t/ha)	Yield (t/ha)
Phosphoric acid and 1.5 kg/ha MnSO4 liquid and Gran Urea	79	0.34	3.4	1.30
Phosphoric acid and 3 kg/ha MnSO4 liquid and Gran Urea	81	0.30	3.3	1.28
Phosphoric acid and Gran urea (equivalent 50 kg/ha DAP)	75	0.39	3.3	1.24
Phosphoric acid and liquid product	92	0.32	3.2	1.24
APP and UAN (equivalent 50 kg/ha DAP) and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	84	0.28	3.0	1.16
DAP and Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	89	0.25	2.9	1.08
DAP and liquid product	88	0.25	2.9	1.08
DAP with Mn coated fertiliser 1.5 kg/ha	109	0.23	2.6	1.07
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha	82	0.21	2.5	1.00
Control	96	0.23	2.3	0.95
DAP and Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	108	0.21	2.4	0.91
LSD (P=0.05)	*19*	*0.10*	*0.7*	*0.16*

The trial at Streaky Bay was very uneven and had patchy growth due to moisture stress early as well Rhizoctonia disease expression. The Streaky Bay nutrition trial had visual differences in early growth with the phosphoric acid treatments looking better than other treatments. The phosphoric acid treatments were the highest yielding (Figure 2). The grain quality at Streaky Bay was not affected by treatments and averaged test weights of 82.4 (kg/hL), protein of 10.8% and screenings of 5.3% for both trials.

The fungicide trial was generally more even in growth earlier in the season than the nutrition trial, but Rhizoctonia patches were still present. There were no treatments which were visually better in the fungicide trial during the season. There were no differences in early and late dry matter (data not presented) or yield in the fungicide treatments in 2015 (Table 2), despite reasonable levels of Rhizoctonia seminal and crown root infection.

In 2015 there was a 0.11 t/ha (8%) yield increase from 1.25 t/ha using granular DAP to 1.36 t/ha using phosphoric acid in this soil type in a dry season. A similar trial conducted at Streaky Bay, in 2014, showed a 0.13 t/ha yield increase (13%) over DAP using phosphoric acid as the phosphorus source.

The trace element treatments or manganese treatments did not improve yield at either site in 2015.

What does this mean?

Consistent improvements in grain yield have been observed through using a fluid form of phosphorous (phosphoric acid) over a granular product on the highly calcareous sandy loams soils of Streaky Bay in both 2014 and 2015. However yield improvements to the same products were not observed on the red sandy soil at Warramboo in either year. This highlights the specific soil type benefit in using fluid phosphorous fertilisers and their advantage on calcareous soil types.

In 2015 trails at both Streaky Bay and Warramboo were unable to demonstrate any yield advantage to using a range of fungicides aimed at controlling rhizoctonia. The current research on fungicides for rhizoctonia control shows yield variation between seasons which may depend on spring rainfall (McKay, A., *et. al*). Using break crop rotations and lowering rhizoctonia inoculum levels before a cereal crop may be the best option. All current information should be taken into account when formulating a management plan to control rhizoctonia in high risk situations.

These trials will be sown again in 2016 to have a better understanding of the best fertiliser mixes and fungicide applications and to increase confidence in fluid delivery systems.

Acknowledgements

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Disease

Fluid delivery systems and fungicides in wheat

RESEARCH

Amanda Cook, Ian Richter, Nigel Wilhelm and Sue Budarick
SARDI, Minnipa Agricultural Centre

Searching for answers

Location:
Warramboo
Darren Sampson and family
Rainfall
Av. Annual: 313 mm
Av. GSR: 227 mm
2016 Total: 333 mm
2016 GSR: 251 mm
Yield
Potential: 2.8 t/ha (W)
Actual: 2.1 t/ha
Paddock History
2016: Mace wheat
2015: Medic pasture
Soil Type
Red sandy loam
Plot Size
20 m x 2 m x 3 reps

Location:
Streaky Bay
Luke Kelsh and family
Rainfall
Av. Annual: 379 mm
Av. GSR: 304 mm
2016 Total: 485 mm
2016 GSR: 323 mm
Yield
Potential: 5.0 t/ha (W)
Actual: 2.3 t/ha
Paddock History
2016: Mace wheat
2015: Medic pasture
Soil Type
Grey calcareous sandy loam
Plot Size
20 m x 2 m x 3 reps

Key messages

- **Phosphoric acid as a fertiliser and granular P performed similarly at Streaky Bay in the wetter 2016 season. In the previous two years, phosphoric acid resulted in 13 and 8% higher yields in 2014 and 2015, respectively.**
- **In 2016 there was a small yield response to phosphoric acid over granular P at Warramboo.**
- **Fungicides and the addition of extra 40 kg/ha urea at seeding separately reduced Rhizoctonia seminal root infection compared to the control at both sites.**
- **Including fungicides will increase input cost and risk over a cropping program.**
- **The addition of a trace element mix or manganese did not improve yields at Streaky Bay or Warramboo.**

Why do the trial?

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.

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 may improve disease control and increase production. Trials were undertaken 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 previous two years of trials in this project are reported in Eyre Peninsula Farming Systems Summary 2015, *Fluid delivery systems and fungicides in wheat* p114 and Eyre Peninsula Farming Systems Summary 2014, *Fluid delivery systems and fungicides in wheat at Warramboo and Streaky Bay* p98.

How was it done?

In 2016, three replicated trials were established, one 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 fungicide fluid system split fluids both below the seed at approximately 3 cm, and in the seeder furrow behind the press wheel in a 1 cm band width.

The control treatment 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 units of phosphorus (P) and balanced with urea or UAN to 10 units of nitrogen (N). Manganese (Mn) was selected as the main focus trace element, with zinc (Zn) and copper (Cu) also included in the trace element mix. A DAP fertiliser dry blend with Mn @ 1.5 kg/ha was used. Phosphoric acid and granular urea, and 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 on 14 July in Streaky Bay and 21 July at Warramboo. The extra nitrogen at seeding treatment was applied as 40 kg/ha of granular urea.

The fungicides azoxystrobin + metalaxyl-M (Uniform), penflufen (new formulation of EverGol Prime) 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.

The Streaky Bay trial was sown on 19 May. Herbicides were applied and included 1.5 L/ha of trifluralin, 2 L/ha of glyphosphate and 80 ml/ha of carfentrazone-ethyl and a wetter. All treatments were sprayed on 28 June with tralkoxydim at 500 g/ha, clopyralid at 75 ml/ha, sulphate of ammonia at 800 g/100 L and paraffin oil, to control weeds in-crop. Snail bait was also applied. The Warramboo trial was sown on 26 May and received the same pre-emergent herbicide mix as at Streaky Bay. In-crop pest control on 1 July included 1 L/ha of flumetsulam, 750 ml/ha of chlorpyrofos insecticide and snail bait.

Trace element treatments were delivered as foliar applications at 4-5 leaf stage on 14 July in Streaky Bay and 21 July at Warramboo.

PreDictaB disease inoculum levels (RDTS), plant establishment, Rhizoctonia seminal root score, Rhizoctonia crown root score, green leaf area index, grain yield and quality were measured during the season.

Rhizoctonia infection on seminal roots and crown roots was assessed using the root scoring method described by McDonald and Rovira (1983) approximately eight weeks after seeding, on 19 July at Streaky Bay and 3 August at Warramboo. Crown roots per plant were also counted on these samples with the number of roots infected with Rhizoctonia used to calculate % crown root infection.

Due to the good seasonal conditions all treatments received an extra 70 kg/ha of urea broadcast in-crop after root sampling on the 22 July at Streaky Bay and 9 August at Warramboo. Trials were harvested on 15 November at Streaky Bay and 23 November at Warramboo. Data were analysed using Analysis of Variance in GENSTAT version 16.

What happened?

Initial Predicta B inoculum was high risk of Rhizoctonia at Streaky Bay (201 pg DNA/g soil), and a low Rhizoctonia risk at Warramboo. All other tested diseases were low at both sites.

Both sites have alkaline pH, reasonable soil phosphorus levels and adequate nutrient levels (Cu and Zn marginal at Streaky Bay) (Table 1). Mineral nitrogen level was much higher at Streaky Bay than Warramboo and the PBI is also higher, especially in the 0-10 cm zone.

Plant establishment in ideal seeding conditions at Streaky Bay averaged 142 wheat plants/m^2. Rhizoctonia patches were visible in the Streaky Bay trial early in the season, however disease symptoms were much lower than in previous years, as soil moisture stress was low and early plant growth was not as limited. The trial at Warramboo was sown later due to low soil moisture, but had good plant establishment, with an average of 147 plants/m^2. There were no differences in plant establishment due to treatments applied at either site. The trial at Warramboo had lower risk of rhizoctonia infection, which may be due to the inclusion of a pasture phase in 2015, which may have reduced inoculum levels compared with a wheat phase (Cook, *et al* 2010), but some Rhizoctonia patches were present in the trial area early in the season.

The Streaky Bay nutrition trial had no visual differences in early growth this season, unlike previous seasons when the phosphoric acid treatments looked better than other treatments. There were no differences in late dry matter or yield attributable to the nutrition treatments in 2016 at Streaky Bay (Table 2). Grain quality at Streaky Bay was not affected by treatments and averaged test weights of 80 kg/hL, protein of 9.8% and screenings of 1% for both trials (data not presented).

The fungicide trial was slightly more even in 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%) in the fungicide treatments in 2016 (Table 3). There were slight differences in yield but only the phosphoric acid + trace element + fungicide (Uniform) split + extra nitrogen treatment was significantly different to the control. This treatment and the similar treatment without the extra nitrogen, and the EverGol Prime (new formulation) with extra nitrogen also had lower Rhizoctonia seminal root infection scores than the control treatment in 2016.

Table 1 Soil analysis of Streaky Bay and Warramboo sites in 2016

Location	Depth (cm)	pH (CaCl)	Cowell P (mg/kg)	PBI	Total soil N (kg/ha)	DTPA Cu (mg/kg)	DTPA Mn (mg/kg)	DTPA Zn (mg/kg)	Bicarb Sulphur (mg/kg)
Streaky Bay	0-10	8.5	24.7	206	28.9	0.14	1.60	0.24	15.6
	10-30	8.8	12.1	275	46.8	<0.1	0.87	<0.1	10.7
	Total reserves (0-100)				208.0				
Warramboo	0-10	8.7	18.1	84	16.6	0.20	2.61	0.83	4.7
	10-30	8.7	5.4	150	9.6	0.21	1.15	0.22	4.9
	Total reserves (0-100)				49.5				

Table 2 Fluid delivery nutrition trial growth measurements (dry matter), yield and grain quality for Mace wheat at Streaky Bay, 2016

Treatment	Plant establishment (plants/m^2)	Early dry matter (g/plant)	Late dry matter (t/ha)	Yield (t/ha)	2016 gross margin ($/ha)*
Phosphoric acid + gran urea + 1.5 kg/ha MnSO4 liquid	133	0.29	5.66	2.42	283
Phosphoric acid + Gran Urea + 3 kg/ha MnSO4 liquid	134	0.30	5.71	2.34	266
Phosphoric acid + Gran Urea (equivalent 50 kg/ha DAP)	133	0.30	6.34	2.38	277
Phosphoric acid + Gran Urea + Liquid TE	145	0.30	5.45	2.36	270
APP + UAN (equivalent 50 kg/ha DAP) + Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	159	0.30	6.38	2.39	284
DAP + Liquid Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	156	0.28	6.17	2.33	278
DAP with Mn coated fertiliser 1.5 kg/ha	154	0.26	6.18	2.34	282
DAP + Foliar Mn @ 1.5 kg/ha (4-5 leaf stage)	119	0.29	5.73	2.45	303
Control	149	0.26	5.66	2.32	280
DAP + Foliar Trace elements (4-5 leaf stage) Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @ 0.2 kg/ha	154	0.30	4.98	2.31	274
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	

**ASW wheat Port Lincoln 1 December 2016 $193, Urea $445 Port Lincoln February 2016*

Table 3 Fluid delivery fungicide trial growth measurements (dry matter), yield and grain quality for Mace wheat at Streaky Bay, 2016

Treatment	Seminal root score (0-5)	Crown root infection (%)	Late DM (t/ha)	Yield (t/ha)	2016 gross margin ($/ha)*
Phosphoric acid + granular urea (equivalent to 50 kg/ha DAP) + Liquid Trace elements (TE) of Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha +Uniform @ 300 ml/ha SPLIT APPLICATION +extra 40 kg/ha granular urea at seeding	2.72 c	68.6	7.46 a	2.62 a	279
Phosphoric acid + urea + Liquid TE +new formulation of penflufen @ 80 ml/ha SPLIT APPLICATION + extra 40 kg/ha granular urea at seeding	2.73 c	78.7	6.53 abc	2.37 abcd	**
Phosphoric acid + urea + Liquid TE + Uniform @ 300 ml/ha SPLIT APPLICATION	2.77 c	82.0	6.82 ab	2.37 abcd	251
DAP +Liquid TE + new formulation of penflufen @ 80 ml/ha	3.03 abc	76.5	5.65 bcd	2.16 bcdef	**
DAP +Liquid TE +Uniform @ 300 ml/ha SPLIT APPLICATION	3.20 ab	75.8	5.55 bcd	2.41 abc	277
DAP + Liquid TE + triadimenol @ 250 g/ha APPLIED ON FERTILISER	3.34 a	83.3	5.75 bcd	2.00 f	215
DAP + Liquid TE + Uniform @ 300 ml/ha + Vibrance seed dressing @ 300 ml/100 kg seed	3.14 ab	82.7	4.87 d	2.12 cdef	211
DAP + Liquid TE + Uniform @ 300 ml/ha APPLIED ON FERTILISER	3.22 ab	78.7	5.49 bcd	2.09 def	215
DAP + Liquid TE + new formulation of penflufen @ 80 ml/ha SPLIT APPLICATION	3.20 ab	76.3	5.37 bcd	2.18 bcdef	**
DAP + Liquid TE + Flutrifol @800 ml/100 kg DAP APPLIED ON FERTILISER	3.13 ab	66.8	5.35 bcd	2.35 abcde	284
Phosphoric acid + urea + Liquid TE + new formulation of penflufen @ 80 ml/ha SPLIT APPLICATION	2.93 bc	66.3	5.70 bcd	2.46 ab	**
Control - 50 kg/ha DAP	3.13 ab	78.2	6.39 abcd	2.21 bcdef	258
DAP+ Liquid TE + EverGol Prime applied as seed dressing @ 80 ml/100 kg/seed	2.95 bc	76.8	5.19 cd	2.05 ef	207
LSD (P=0.05)	*0.31*	*ns*	*1.57*	*0.31*	

**ASW wheat Port Lincoln 1 December 2016 $193, Urea $445 Port Lincoln February 2016*
***new formulation of penflufen, cost unknown*

At Warramboo, in drier conditions, phosphoric acid + trace element +fungicide (Uniform and EverGol Prime 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%) (Table 4). Only the phosphoric acid +with trace element +, fungicide (Uniform) split +and extra nitrogen treatment had higher late dry matter than the control (Table 3). The first five treatments in Table 4 had higher grain yields than the control in this trial in 2016 and all of these had phosphoric acid as the base fertiliser. Grain quality showed no differences with the trial averages being; test weight of 80.0 kg/hL, protein 9.7%, screenings 2.5% (data not presented).

In previous seasons there has been a 0.11 t/ha (8% from 1.25 t/ha using granular DAP to 1.36 t/ha 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 this season.

The 2016 gross margins show the difference compared to the control but the increase in the input costs will result in higher 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.

Table 4 Fluid delivery trial growth measurements (dry matter), yield and grain quality for Mace wheat at Warramboo, 2016

Treatment	Seminal root score (0-5)	Crown root infection (%)	Late DM (t/ha)	Yield (t/ha)	2016 gross margin ($/ha)*
Phosphoric acid + granular urea (equivalent to 50kg/ha DAP) + Liquid Trace elements (TE) of Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha + Uniform @ 300 ml/ha SPLIT APPLICATION + extra 40 kg/ha granular urea at seeding	2.85 d	55	6.77 a	2.41 a	288
Phosphoric acid + urea (equivalent to 50kg/ha DAP) +Liquid TE + new formulation penflufen @ 80 ml/ha SPLIT APPLICATION + extra 40 kg/ha granular urea at seeding	2.90 cd	54	6.39 ab	2.36 ab	**
Phosphoric acid + urea (equivalent to 50 kg/ha DAP) + Liquid TE	-	-	5.82 bcde	2.28 abc	299
Phosphoric acid + urea + 3 kg/ha MnSO4 liquid	-	-	6.15 abc	2.27 abcd	298
Phosphoric acid + Liquid TE + Uniform @ 300 ml/ha SPLIT APPLICATION	3.10 abcd	51	5.44 cdef	2.27 abcd	278
DAP +Liquid TE + new formulation of penflufen @ 80 ml/ha	3.17 abc	58	5.36 def	2.23 bcde	**
DAP + Liquid TE + Uniform @ 300 ml/ha SPLIT APPLICATION	3.10 abcd	51	5.17 ef	2.16 cdef	272
Phosphoric acid + urea + 1.5 kg/ha MnSO4 liquid	-	-	6.37 ab	2.16 cdef	278
DAP + Liquid TE +triadimenol @ 250 g/ha APPLIED ON FERTILISER	3.20 ab	58	5.40 cdef	2.15 cdef	289
DAP and Liquid TE and Uniform @ 300 ml/ha and Vibrance seed dressing @ 300 ml/100 kg seed	3.08 abcd	49	5.36 def	2.15 cdef	264
DAP + Liquid TE + Uniform @ 300 ml/ha APPLIED ON FERTILISER	3.32 ab	60	5.15 ef	2.15 cdef	270
DAP and Liquid TE and new formulation penflufen @ 80 ml/ha SPLIT APPLICATION	3.30 ab	56	5.24 ef	2.13 cdef	**
DAP + Liquid + flutriafol @800 ml/100 kg DAP APPLIED ON FERTILISER	3.25 ab	66	5.39 cdef	2.13 cdef	285
DAP + Foliar Trace elements Mn @ 1.5 kg/ha, Zn @ 1 kg/ha, Cu @0.2 kg/ha (4-5 leaf stage)	-	-	6.04 abcd	2.13 cdef	285
Phosphoric acid + urea + Liquid TE + new formulation of penflufen @ 80 ml/ha SPLIT APPLICATION	3.03 bcd	54	5.58 cde	2.13 cdef	**
DAP + Liquid TE			4.79 f	2.12 def	283
Control 50 kg/ha DAP	3.34 a	63	5.63 bcde	2.08 ef	278
DAP + Liquid TE + EverGol Prime applied as seed dressing @ 80 ml/100 kg/seed	3.07 abcd	51	5.16 ef	2.08 ef	266
Phosphoric acid + urea	-	-	5.92 bcde	2.08 ef	264
APP + UAN (equivalent 50 kg/ha DAP) + Liquid TE	-	-	5.55 cdef	2.06 f	265
DAP + granular Mn fertiliser @ 1.5 kg/ha	-	-	5.44 cdef	2.03 f	267
DAP + Foliar Mn @ 1.5 kg/ha (4-5 leaf stage)	-	-	5.44 cdef	2.02 f	265
LSD (P=0.05)	*0.29*	*ns*	*0.77*	*0.15*	

**ASW wheat Port Lincoln 1 December 2016 $193, Urea $445 Port Lincoln February 2016*
***new formulation of penflufen, cost unknown*

What does this mean?

The trial results 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 of Streaky Bay. However in 2016 at Streaky Bay the phosphorus source did not show a yield response. Yield improvements to the fluid form of phosphorous (phosphoric acid) were not observed on the red sandy soil at Warramboo in either 2014 or 2015.

Previous research has shown in drier soil conditions the movement of phosphorus to the plant roots in the soil water 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*, 2001, Lombi *et al*, 2004). Having a responsive soil type is important before changing to a fluid fertiliser system for phosphorus and soil moisture conditions may play a role in the responsiveness of the fluid phosphorous fertilisers.

In 2016 at both Streaky Bay and Warramboo there were seminal root infection differences for Rhizoctonia with the split application of fungicides and extra nitrogen and a yield advantage over the control. The most reliable method to reduce Rhizoctonia inoculum and disease levels has been to include a break crop rotation before a cereal crop (Gupta, *et al*, 2013). All current information, including the increased input costs, should be taken into account when formulating a management plan to control rhizoctonia in high risk situations.

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SAGIT

Fluid delivery systems in canola

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RESEARCH

Disease

Searching for answers

Location:
Wangary
Morgan family
Rainfall
Av. Annual: 525 mm
Av. GSR: 465 mm
2016 Total: 604 mm (no data for Dec 2016)
2016 GSR: 480 mm
Yield
Potential: 5.9 t/ha (C)
Actual: 2.2 t/ha
Paddock History
2016: CL canola
2015: Lupins
2014: Wheat
Soil Type
Grey loamy clay
Plot Size
20 m x 2 m x 3 reps

Key messages

- **Fungicides as seed treatments or in-furrow did not increase canola yield in 2015 or 2016.**
- **In 2016 Intake (on fertiliser) and Jockey (on seed) which is current standard practice, lowered Blackleg stem infection, and in 2014 this treatment increased yield.**

Why do the trial?

A SAGIT Fluid delivery project was funded to update the benefits of fluid delivery systems from previous research and assess the potential of fluid nutrient delivery systems and disease control strategies compared to current systems. The fluid systems have the potential to increase production through delivery of micro and macro nutrients, lower cost of trace element delivery and better control of cereal and canola root and leaf diseases.

Blackleg continues to be a major issue facing canola growers especially on lower Eyre Peninsula and fluid delivery systems for product delivery may increase production and improve disease control. With the development of fungicides and the ability to deliver liquid products around the seed row during the seeding pass, there is now a range of application strategies available to growers to make use of these new products. This trial investigated the relative benefits of a range of fungicide strategies for blackleg control on canola.

The previous two years of trials in this project are reported in Eyre Peninsula Farming Systems Summary 2015, *Fluid delivery systems in canola* p118 and Eyre Peninsula Farming Systems Summary 2014, *Fluid delivery systems in canola* p104.

How was it done?

The trial was sown on 10 May 2016 at Wangary. Base fertiliser was 100 kg/ha of DAP (18:20:0:0) with in furrow fungicides and trace elements delivered as fluids. The trace element mix was Mn at 1.5 kg/ha of manganese sulphate, 1 kg/ha Zn as zinc sulphate and 0.2 kg/ha Cu as copper sulphate delivered at a water rate of 100 L/ha. The fungicides Jockey, Intake, Aviator and Prosaro were evaluated for blackleg disease control.

Plant establishment, blackleg infection and grain yield were measured during the season. Blackleg infection was scored by assessing 20 stems per plot, cut at the base, in mid-November. The trial experienced some late hail damage so scoring for % pod infection was not undertaken as planned.

The paddock was sprayed on 10 May with 2 L/ha glyphosate with wetter, 1.5 L/ha of trifluralin and 80 ml/ha of carfentrazone-ethyl. Weed control was achieved on 20 June with L clopyralid @ 150 ml/ha and clethodim @ 500 ml/ha with a wetter. Urea was applied @ 80 kg/ha on 26 June and again on 25 July.

Foliar Aviator and Prosaro were applied at 400 ml/ha and 550ml/ha respectively, on 15 June at the 4 leaf stage.

The trial was desiccated on 8 November with glyphosate @ 3 L/ha (470 g/L as potassium and mon-ammonium salts) and alcohol alkoxylate @ 200 ml/100L. The trial was harvested on 25 November 2016.

Data were analysed using Analysis of Variance in GENSTAT version 16.

What happened?

The trial was located at Wangary within an intensive canola cropping region with a potentially high Blackleg disease pressure. Establishment was reduced by nearly 20% with Jockey on seed (Table 1), but plant numbers were still reasonable at 38 plants/m².

Blackleg infection was moderate but quite variable across the site as were grain yields. Blackleg stem infection averaged 18% across the site. The blackleg stem infection was reduced by using both a seed dressing and an in-furrow fungicide in 2016, although this did not result in a significant yield increase (Table 1).

Table 1 Disease scores, growth measurements and yield for CL canola with fungicide treatments in Coulta trial, 2016

Fungicide treatment	Canola establishment (plants/m²)	Blackleg score (% infection)	Yield (t/ha)
Intake (in furrow)	39.7 [ab]	22 [a]	2.4
Intake (on fertiliser)	41.8 [ab]	12 [bc]	2.7
Intake (on fertiliser) and Jockey (on seed)	38.3 [b]	9 [c]	2.2
Jockey (seed)	38.3 [b]	23 [a]	2.0
Control	47.1 [ab]	20 [ab]	1.9
Aviator Foliar	47.1 [ab]	14 [abc]	2.3
Prosaro Foliar	57.5 [a]	18 [abc]	2.3
LSD (P=0.05)	*10.9*	*9.6*	*ns*

What does this mean?

In 2015 and 2016 there were no consistent differences canola yields due to fungicides. In 2016 there was a significant decline in blackleg stem infection with the use Intake (on fertiliser) and Jockey (on seed). In 2014 the same combined fungicides increased yield over the nil fungicide control, but there were no significant differences in blackleg infection.

The application methods for blackleg fungicides in the trial have shown little or no change in either blackleg disease control or yield with their use. Further evaluation with the newer products in the lower EP environment will continue. The selection of resistant varieties with high blackleg ratings is important, as is paddock rotation with other break crops to lower the disease pressure.

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Registered products: see chemical trademark list.