FINAL REPORT 2015

Applicants must read the *SAGIT Project Funding Guidelines 2014* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be emailed to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.

PROJECT CODE :	UA1201

PROJECT TITLE (10 words maximum)
Evaluating the agronomic and financial benefits of P-efficient cereal varieties

PROJECT DURATION

*These dates **must** be the same as those stated in the Funding Agreement*

Project Start date	01/07/2012
Project End date	30/06/2015

PROJECT SUPERVISOR CONTACT DETAILS

The project supervisor is the person responsible for the overall project

Title:	**First Name:**	**Surname:**
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Office Use Only

Project Code	

Project Type	

ADMINISTRATION CONTACT DETAILS

The Administration Contact is the person responsible for all administrative matters relating to the project

Title:	**First Name:**	**Surname:**	
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Organisation:			
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Telephone:	**Facsimile:**	**Mobile:**	**Email:**

PROJECT REPORT

Provide clear description of the following:

Executive Summary (200 words maximum)

A few paragraphs covering what was discovered, written in a manner that is easily understood and relevant to SA growers. A number of key dot points should be included which can be used in SAGIT communication programs

Phosphorus nutrition for S.A. growers continues to be a major challenge in order to maximize yields and income.

Compared to differences in yield among varieties, differences in responses to P have been small. At this stage variety selection should be based on yield rather than any differences in PUE to achieve the greatest return in investment from P.

Phosphorus nutrition levels should be continually monitored especially those on replacement P programs and soil types with moderate to high PBI levels (>80). Unless the relative inefficiency of P applications and the capacity of some soils to fix P have been considered, replacement P inputs on these soil types could be driving down P levels.

More efficient replacement P rates could be obtained if they are adjusted in accordance with PBI levels if they vary significantly within a paddock. We encourage the continued use of farmer strip trials (leave a strip of nil P fertiliser) in combination of with Colwell P and DGT results for on farm validation of the soil tests. P rich strips are also encouraged (e.g. 40 kg P/ha) to ensure P deficiency is not masked by relative low fertiliser efficiency.

The economics of high P rates in order to maximize yields on moderate PBI soils needs serious consideration.

Project Objectives

A concise statement of the aims of the project in outcome terms should be provided.

The aim of this project is to quantify the economic benefit to farmers in different rainfall zones of growing wheat and barley varieties that differ in their phosphorus use efficiency (PUE). To achieve this aim, the project will:

- Quantify yield responses to P at a number of sites of varieties previously identified to differ in PUE;
- Determine the economic optimum P rate for varieties with different PUE; and
- Estimate the economic returns from P responsive and P non-responsive genotypes in high and low rainfall environments.

Overall Performance

A concise statement indicating the extent to which the Project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

Project objectives were thoroughly tested over the course of three growing seasons in different growing regions. Through soil testing deficient P sites were easily located and these tend to be sites where there is a reasonable amount of P tie up potential which can be measured through PBI. The project did have some difficulty in achieving yield response curves over the three years as the response to P was often linear in nature. Low efficiency of applied P meant that throughout the course of the project maximum P rates were adjusted even though they had started out much higher than district practice (16 kg P/ha – 2012, 25 kg P/ha – 2013 and 40 kg P/ha -2014). The inability to maximize yields through P application often hindered analysis of any differences in PUE % between varieties. In years 2 and 3 (2013, 2014) we were able to obtain significant differences in grain yields overall between wheat and barley varieties. Economic analysis across all sites discovered that in most cases sufficient gains can be made by applying P rates above normal replacement rates if you're in a deficient scenario. Alternatively at Condowie, maximizing yields with P application was uneconomical and therefore further work needs to be aimed at assessing when these occurrences might occur (see future work).

The project team would like to acknowledge the effort of the various field teams/ co-operators listed below.

Rob Wheeler

Willie Schoobridge

Charlton Jeisman

Leigh Davis

Key Performance Indicators (KPI)

*Please indicate whether KPI's were achieved. The KPI's **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***

Analysis of data from both sites for the 2012 growing season completed	**Y**	Two P responsive trials were achieved at Minnipa and Mallala. A third trial at Karoonda proved to be P non responsive
Progress report submitted for assessment	**Y**	
Analysis of data from both sites for the 2013 growing season completed	**Y**	P responsive trials were achieved at Minnipa and Mallala. A third trial at Swan Reach was damaged by sheep.
Progress report submitted for assessment	**Y**	
Analysis of data from both sites for the 2014 growing season completed	**Y**	P responsive field trials were achieved at Condowie and Sherwood
Final project report submitted	**Y**	

Technical Information (Not to exceed **three** pages)

Provide sufficient data and short clear statements of outcomes.

Further information has been included in a supplementary document. This document outlines internal P requirements and some economic analysis of the trials which couldn't fit in this final report.

Year 1: Further information can be found in the submitted 2013 progress report

Site selection:

Three replicated field trials (both with wheat and barley) were established at Minnipa, Mallala and Karoonda. Soil P levels as assessed by DGT from all three sites suggested a response to P applications was expected at Minnipa and Mallala but not at Karoonda (Table 1). Karoonda was initially selected on the basis of a spot soil sample taken at the site before sowing revealing a low DGT value (29 µg/L) but sampling at the actual location of the trial suggests P levels were higher.

Results:

Minnipa

Significant responses ($p < 0.05$) to P applications were obtained in biomass production and in grain yield. There was no significant difference in the yields among the wheat and barley varieties, nor was there a Variety x P interaction At maturity the P rate in wheat that produced 90% of the maximum yield was 17 kg P/ha, while the response in barley was linear (Table 1).

Mallala

Significant responses ($p < 0.05$) to P applications were obtained in biomass production and in grain yield. There was no significant difference in the yields among the wheat and barley varieties, nor was there a Variety x P interaction for wheat but a significant effect for barley at maturity only. The only significant effect was present with Fleet with some other varieties at P application rates of 2 and 4 kg/ha and therefore this needs to be confirmed with other trials as this trend was not seen at Minnipa. At maturity, the P rate in wheat that produced 90 % of the maximum yield was 14 kg P/ha, compared to 17 kg/ha for barley. As for Minnipa it appears barley is less efficient (with the exception) of Fleet in regards to utilising applied P (Table 1).

Karoonda

No significant response to P was observed in biomass production or in grain yield at Karoonda and therefore no PUE comparisons between varieties could be assessed (Table 1). This supports soil test results collected in the actual field trial which indicated sufficient levels of P were present. Karoonda soil test results also highlights the importance of correcting Colwell P values with PBI as a Colwell P value of 15 mg/kg would be considered below critical in most datasets.

Overall

While it appeared that some differences in PUE were expressed by different varieties of wheat and barley, unfortunately the degree of response was not large enough to identify significant trends. Insufficient amounts of P being applied in some instances (e.g. Minnipa) caused some uncertainty with the calculation of Ymax and therefore PUE. For the 2013 trials sites (year 2) lower P levels will be sought and P rates will be revised in order to overcome issues raised in 2012.

<u>Year 2: Further information can be found in the submitted 2014 progress report</u>

Site Selection

Three experiments were conducted in 2013 at Minnipa, Mallala and Swan Reach.

Results:

Swan Reach

Unfortunately no results could be obtained as the trial was devastated by sheep soon after stem elongation.

Minnipa and Mallala

Significant responses to P were obtained for both wheat and barley at both sites (Table 1). However, responses were generally lower than expected based on 2012 results and soil test analysis for 2013. In addition, the response to P was linear in most cases which was a surprising result given that P rates were increased to 25 kg P/ha in 2013 in order to overcome linearity observed in 2012. Unfortunately this means that we struggled to identify differences in responsiveness among varieties and to identify optimum P rates. In terms of PUE it is difficult to compare sites and years in order to see if consistency between crops exists as PUE determination is based on confidently identifying maximum yield values. For varieties where an optimum P rate can be identified there doesn't seem to be a consistent trend between sites and across years.

Sampling in 2012 showed that PBI values were in the moderate category (Minnipa – 78, Mallala – 113) therefore it appears that applying P in the form of TSP is quite inefficient on soils that are alkaline in nature even at moderate PBI levels.

Table 1. Average responses to P in experiments conducted in 2012 and 2013.

			P rate (kg/ha)						
Year	**Crop**	**Site**	**0**	**2**	**4**	**8**	**16**	**Signif**	**Yield response (%)**
2012	Wheat	Minnipa	1905	1969	2121	2195	2365	P<0.001	24
		Mallala	1272	1393	1452	1511	1608	P<0.001	26
		Karoonda	361	396	399	415	375	P<0.05	4
2012	Barley	Minnipa	2115	2204	2168	2333	2548	P<0.001	20
		Mallala	1644	1859	1910	2025	2134	P<0.001	30
		Karoonda	922	978	955	1002	963	NS	0
2013	Wheat	Minnipa	2015	2125	2146	2207	2336	P<0.001	16
		Mallala	2683	2729	2771	2779	2812	P<0.01	5
2013	Barley	Minnipa	2589	2683	2744	2833	2852	P<0.001	10
		Mallala	3064	3106	3187	3173	3247	P<0.001	6

Year 3: Further information can be found in the submitted 2015 progress report

Site selection:

Previous experiments conducted at MAC and Mallala in 2012 and 2013 revealed small significant responses to P applications among various wheat and barley varieties however no significant differences could be obtained for PUE potentially due to the relatively small yield response obtained. Trials were repeated in 2014 at Condowie and Sherwood where very low P levels (DGT, Colwell P) were measured in an attempt to generate greater yield responses to P and identify if there are any significant differences in PUE between varieties.

Results:

Significant responses to P applications and significant differences among varieties were obtained for grain yield in both wheat and barley at both sites (Table 3). Despite overall larger responses to P compared to the 2012 and 2013 seasons there was no significant Variety x P interaction in either wheat or barley at either site. In other words, for both wheat and barley the yield differences among the 6 varieties were too small to pick up significant differences in their responsiveness to P. Barley varieties tended to yield higher than wheat especially at Condowie which in part can be attributed to the occurrence of yellow leaf spot at early development for susceptible wheat varieties (Scout, Correll) as the trial was sown into wheat stubble.

Despite similar initial soil tests at the two sites (data not shown) responses to P at Condowie were smaller than those at Sherwood and the yield response was linear over the range of P rates. The difference between the sites appears to be driven by P fixation and resulting fertiliser efficiency which has been effectively measured by PBI. Fertiliser requirements at Condowie appear to be at least double that of Sherwood even though both sites had very similar starting available P levels

While highly significant responses to P were obtained at Condowie the smaller response to P meant that yields at the low P rates were not significantly greater than the control for a number of the varieties and significantly greater yields were only achieved at 25 or 40 kg P/ha. Phosphorus deficiency could therefore be masked if trials on this soil type

used rates below 25 kg P/ha and thereby give a false impression that P was not limiting.

Despite required P rates at Condowie being calculated at the highest rate of P used (40 kg P/ha) or greater, the relatively flat linear response meant that the yields obtained in 2014 at these higher P rates (> 25 kg P/ha) were not necessarily the most economical with current grain and fertiliser prices. At Keith economic benefits were obtained above typical replacement rates due to the higher relative efficiency of P applications (see supplementary information).

Table 3. Mean yields across all P rates for each variety at each field site

Variety	Sherwood GY (kg/ha)	Condowie GY (kg/ha)	Variety	Sherwood GY (kg/ha)	Condowie GY (kg/ha)
Barley			Wheat		
Barque73	3255	2962	Correll	2705	2386
Commander	3151	2962	Gladius	2647	2294
Fleet	3471	2939	Mace	3019	2341
Galleon	2545	2816	RAC875	2756	2344
Hindmarsh	3312	2853	Scout	2583	1802
Yarra	2587	2617	Wyalkatchem	2827	2296
LSD (P=0.05)	451	254	LSD (P=0.05)	380	359
CV%	8	5	CV%	8	9

Conclusions Reached &/or Discoveries Made (Not to exceed one page)

Please provide concise statement of any conclusions reached &/or discoveries made.

Any difference in PUE between varieties has been difficult to observe due to natural field trial variability even though greater yield responses were obtained in 2014. Gains in yields through breeding new and improved varieties appear to outweigh any advantage of potentially growing P efficient varieties on P deficient soils. At current prices for fertiliser and grain it would be recommended to achieve maximum yields through sufficient P applications and growing appropriate varieties for the region as opposed to selecting potential high PUE varieties. However comparisons of PUE % of new varieties that have been consistently performing well in NVT trials in S.A. should be worth some significant thought as P deficiency in some soils might be hard to amend due to their natural P fixation ability. Inability to define differences in PUE% between varieties in this project might have been attributed in part to trial design. By including 6 varieties of each wheat and barley meant 3 replicates and 5 rates of P could be used. Reducing varieties to 3-4 of the most important (data from NVT trials) would allow 4 replicates and 6 P treatments which would increase the chances of defining differences in PUE %.

There is a danger that current replacement P programs that attempt to match P removed off paddock in grain products are not flexible to varying fixation abilities of different soil types. Required P rates required at sites across the project were considerably higher than the replacement P rates required based on average grain

yields. Using the standard replacement rate of 3 kg P/tonne wheat grain, inputs would be approximately between 6 and 9 kg P/ha across all our trial sites compared to the predicted higher required rates based on yield response curves from trials across the three seasons.

Intellectual Property

Please provide concise statement of any intellectual property generated and potential for commercialisation.

This project has built on IP from previous work associated with assessment of PUE % of different varieties (Glenn McDonald) and overall phosphorus nutrition work performed over several years of research in this area.

All the varieties used in this project are already commercially available apart from wheat variety RAC 875.

Minimal commericalisation opportunities exist but the project builds on best management practice under low P conditions with variety choice and fertilizer rate recommendations.

Application / Communication of Results

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

Differences in PUE between varieties has been difficult to observe potentially due to natural field trial variability, small overall response to P and the inability to reach Ymax with P fertiliser rates on many occurrences.

Gains in yields through breeding new and improved varieties appear to outweigh any advantage of potentially growing P efficient varieties on P deficient soils.

Further economic analysis is required to assess whether high P fertiliser rates that are required on selected soils are a viable option.

Phosphorus deficiency is still a major limitation to maximizing yields on selected soils across broad acre regions in S.A.

Potential industry impact:

The general consensus in the agricultural industry is that P deficiency situations are now harder to find due to a long history of P inputs. Replacement P programs have been advocated as a result but these programs only work if the soil P status has been confirmed to be adequate. Moderate to high P buffering soils result in lower efficiencies of applied P application and these soils have been shown to be prone to deficiency. Optimal P rates on these soils might not be economically viable and therefore the emphasis of finding efficient wheat and barley varieties is of utmost importance.

Publications and extension articles delivered as part of the project:

Articles produced in Eyre Peninsula Farming Systems Summary for years 2012, 2013 and 2014
Articles produced in Mallee Sustainable Farming Compendium for years 2013 and 2014
Article produced for Hart Field Site Results Summary 2014
You tube video 2015 to be produced for the SAGIT facebook page

Path to Market:
Education, further articles, field days, presentations and manuscripts.

POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

Phosphorus deficiency still occurs in several regions across S.A. with major yield limitations occurring due to inadequate applications of P. Low soil P test values are commonly associated with soils that have moderate to high P buffering indices (> PBI 100) implying that replacement P programs may not be sufficiently accounting for the low fertiliser recoveries, thereby generating inadequate P replacement rates. In some cases application rates > 40 kg P/ha might be required to maximise yields, a fertiliser rate that under some circumstances might not be the most economic if yields are low. Identifying these sites and assessing under which circumstances (yield potential, fertiliser prices) high rates of P are economically-viable will add vital information to the grains industry.

Wheat and barley varieties may vary in their responsiveness to P either by having root traits that increase access to soil P or by more efficient use of the P that is taken up. In combination with different yield potentials external P requirements and phosphorus use efficiency (PUE) could vary. Identifying varieties that have greater PUE in deficient soil is of great interest to many farmers in S.A. due to the relatively low P levels driven by moderate to high P fixing soils in several regions. Recent NVT trials indicate that selected new varieties of both wheat and barley will provide major opportunities to increase yields in S.A. broad acre agriculture. Therefore it would be of great significance to the grains industry of these new varieties are assessed for PUE and might become an economic option on these problematic soils.

This work will be investigated through a new SAGIT funded project titled “Reassessing the value of P replacement strategies on fixing soils”.

AUTHORISATION
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Date: 03/09/2015

Submit report via email to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.