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Section 5

Nutrition

Crop production using replacement P

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RESEARCH

Almost ready

Location:
Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm
Yield
Potential: 4.0 t/ha
Actual: 2.9 t/ha
Paddock History
2010: Wheat
2009: Wheat
2008: Wheat
Soil Type
Red sandy loam
Plot Size
1.4 x 9 m x 4 reps
Yield Limiting Factors
Leaf rust and dry spell in spring
Environmental Impacts
Water Use
Water use efficiency: 11.5 kg/ha/mm
Runoff potential: Low
Resource Efficency
Greenhouse gas emmisions (CO_2, NO_2, methane): Changed fertiliser input
Social/Practice
Time (hrs): No extra
Clash with other farming operations: Standard practice
Economic
Infrastructure/operating inputs: No change
Cost of adoption risk: Medium

Key message

- **Over 3 years of crop production (2009-2011) applying replacement phosphorus (P) rates have been the most economic.**

Why do the trial?

There has been an accumulation of P reserves in many cropping soils as a result of application rates in excess of crop demand over a run of poor seasons prior to 2009. To better match the import and export of P, replacement P application rates are being investigated. A replacement P rate is based on the estimated P exported from the paddock as product (grain, hay or livestock) calculated using a grain P concentration of 3 kg P/ha/t of cereal grain harvested the previous year.

The aim of this study is to assess the crop production and economic outcomes from applying P at nil, replacement, 10 kg P/ha (district practice, DP) and 20 kg P/ha (double district practice, DDP) rates on 2 soil types at Minnipa. This work follows on from articles in the 2009 (pg 154-155) and 2010 (pg 110-111) EPFS Summaries.

How was it done?

Two replicated trials were established in Paddock North 1 (N1) on Minnipa Agricultural Centre (MAC) in 2009; one on a deep red sandy loam (good zone) and the second on a shallow, heavy soil (poor zone). In 2009, Colwell P levels were 25 and 35 mg/kg on the good and poor zones respectively, prior to establishing the trials.

There are four treatments which have been tested for three consecutive years on the same plot (Table 1). P was applied as DAP banded at sowing, with N balanced with urea to give a total of 18 kg N/ha on all treatments. In 2011, both trials were sown with Scope barley on 3 May.

Table 1 shows 2010 yields, the P and DAP applied to each treatment. Measurements during 2011 included dry matter at late tillering, grain yield and quality (Table 2).

What happened?

Soil tests taken before sowing in the 2011 season in the good zone showed that the Colwell P levels had fallen from the 2009 and 2010 levels in all treatments, with the exception of the 20 kg/ha P treatment which remained the same (Figure 1). In the poor zone, the Colwell P levels have dropped in 2011 compared to 2010, except for the 20 kg/ha P treatment, but are similar to the initial 2009 levels. However soil test values from both sites were estimated to be above the critical Collwell P value suggesting little or no response to applied P in 2011 (Figure 1).

Table 1 2010 wheat yields, phosphorus (P kg/ha) and DAP (kg/ha) applied in 2011

P applied	Yield 2010 (t/ha)	P applied in 2011 (kg/ha)	DAP applied in 2010 (kg/ha)
Good zone, deep sandy loam			
0	3.9	0	0
10 (DP)	4.0	10	50
20 (DDP)	4.4	20	100
Replacement P	4.3	12.9	65
Poor zone, shallow constrained soil			
0	3.5	0	0
10 (DP)	3.7	10	50
20 (DDP)	3.9	20	100
Replacement P	3.9	11.7	53

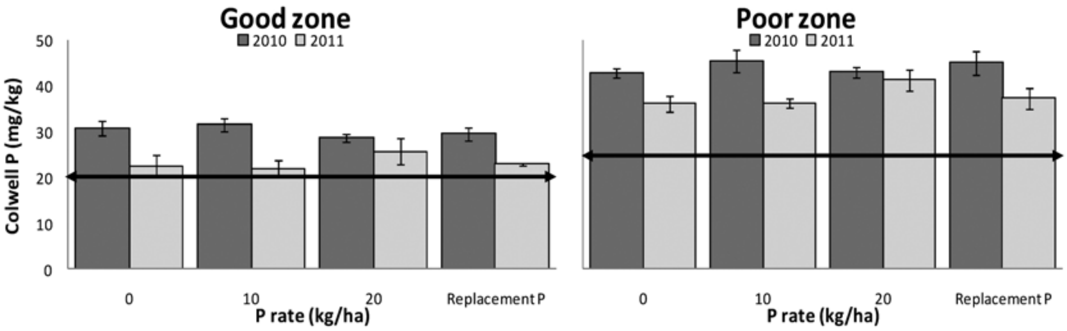

Figure 1 Colwell P values with P treatments prior to sowing in 2010 and 2011. Arrow represents the critical Colwell P value calculated from PBI values at each site. Standard error bars are given on each column.

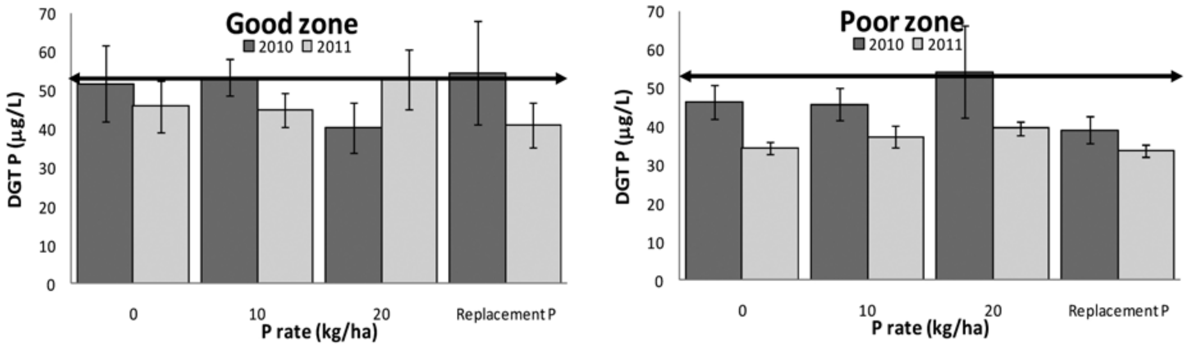

Figure 2 DGT P values measured prior to sowing in 2010 and 2011. Arrow represents the critical DGT P value. Standard error bars are given on each column.

Analysis of the same soil samples using DGT revealed a similar pattern with respect to P treatments and the maintenance of P levels with replacement application rates (Figure 2). The major benefit of using DGT in this circumstance was that it correctly predicted the response seen at both sites with values at or below the critical DGT value. This finding was a repeat of 2010 with DGT values estimated as at or below the critical level and yield increases were measured in response to P applications (Table 3).

As predicted in Figure 2 there was higher grain yield with applied P in both zones. This was reflected in increased dry matter production at tillering in the good zone. The addition of P in the good zone resulted in a lower screening percentage and higher test weight. However the generally low test weights and high screenings percentage is likely to be a result of a late leaf rust infection and the 6 week dry period experienced by the crop in the mid August to late September period.

A gross income analysis on all treatments showed that the Nil P strategy had a similar gross income in 2011as the replacement and 20 kg P (DPP) on good and poor zone respectively, but less on all others. The highest total gross income in 2011 from both zones was produced by the 10 kg/ha P treatment, followed by the replacement P strategy (Table 2). However after 3 years of this trial the cumulative gross income analysis has shown that in 2 out of 3 years a replacement P strategy has performed better than the district practice of 10 kg P/ha in both zones. This has resulted in a higher accumulated gross income for the replacement P strategy.

Table 2 Barley 2011 dry matter (DM) at tillering, grain yield, test weight, protein and screenings in response to P treatments from the 2 zones

P applied (kg/ha)	DM late tillering (t/ha)	Yield 2011 (t/ha)	Test Weight (kg/hL)	Protein (%)	Screenings (%)	Gross Income *($/ha)
Good zone, deep sandy loam						
0	1.4	2.4	58.0	12.0	32.4	386
10 (DP)	2.4	2.9	59.0	11.8	27.3	443
20 (DDP)	2.5	2.9	59.4	11.9	23.8	415
Replacement P	2.1	2.9	59.0	12.2	28.5	434
LSD (P<0.05)	*0.38*	*0.24*	*0.60*	*ns*	*5.8*	
Poor zone, shallow constrained soil						
0	1.5	1.8	58.5	11.9	25.6	226
10 (DP)	1.7	2.1	59.2	11.7	21.5	317
20 (DDP)	1.8	2.0	59.5	11.9	21.5	279
Replacement P	1.9	2.1	59.2	11.7	26.4	306
LSD (P<0.05)	*ns*	*0.14*	*ns*	*ns*	*ns*	

Table 3 Grain yield and gross income in response to P treatments in 2009, 2010, 2011 and the accumulated 2009-11 gross income from the 2 zones

P applied (kg/ha)	2009		2010		2011		Accumulated Gross Income* 2009-11 ($/ha)
	Yield (t/ha)	Gross Income *($/ha)	Yield (t/ha)	Gross Income *($/ha)	Yield (t/ha)	Gross Income * ($/ha)	
Good zone, deep sandy loam							
0	3.9	848	3.9	1025	2.4	386	2259
10 (DP)	4.4	906	4.0	1025	2.9	443	2374
20 (DDP)	4.6	941	4.4	1106	2.9	415	2462
Replacement P	4.3 (2)**	966	4.3 (13.3)	1085	2.7 (12.9)	434	2485
Poor zone, shallow constrained soil							
0	2.9	573	3.5	873	1.8	226	1672
10 (DP)	2.8	548	3.7	944	2.1	317	1809
20 (DDP)	3.1	606	3.9	972	2.0	279	1857
Replacement P	2.7 (1.2)	570	3.9 (8.4)	995	2.1 (11.9)	306	1871

Gross income is yield x price less fertiliser costs delivered cash on 1 December each year
**In the yield column, a number in brackets represents the amount of kg P/ha added.*

What does this mean?

In 2009 and 2010 there was an economic benefit gained from using the replacement P strategy compared to the 10 kg P/ha strategy, especially in 2009 when the level of fertiliser required to replace the P exported the previous 2008 harvest was low (Table 3). In 2011 there was no extra yield from the higher replacement P rates when compared with the district practice rate of 10 kg P/ha in both the poor zone and the good zone of the paddock. However, there was a yield increase from adding 10 kg P/ha compared to the nil P treatment and this yield increase provided a 10% increase in gross income in the good zone and a 9% increase in the poor zone. Due to the slightly higher fertiliser cost for the replacement P strategy, there was a 2% decrease in gross income in the good zone and 4% decrease in the poor zone for replacement P compared to the 10 kg/ha P treatment. Overall in the 3 years of this trial the replacement P strategy has been the most economic.

The Colwell P values suggest that the replacement and 10 kg P/ha treatments are decreasing the P status in both zones while the 20 kg/ha application rate is maintaining P reserves. However at both sites Colwell P critical value estimates from the textbooks suggested sufficient P was present to maintain yields without further P; this was shown to be incorrect with a yield response from P added at both sites, so another example perhaps of industry standards needing to be tweaked for the upper EP environment.

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DGT results produce a specific site measure whereby a grain yield response is expected when P values fall below that measure or level, this method is more accurate than using Colwell P which can tend to overestimate P reserves on calcareous soils. In both 2010 and 2011 there was a grain yield response to applied P when DGT values were either at or below that critical level. There were no levels above the critical level to assess a yield response or a lack of a yield response. Please refer to the P management article for the economic implications of incorrectly predicting P soil levels and also an update on the DGT as a commercial service.

This trial will continue in 2012 with appropriate soil analysis carried out to measure any further changes in soil P and if there is any impact of differing P regimes on crop performance. The results from this trial will undergo a financial assessment to evaluate the merits of each system after the end of the 2012 season.

Acknowledgements

We acknowledge the funding from GRDC project UA00107 for this work. Thanks to Roy Latta and Nigel Wilhelm for advice on this trial. Thanks also to Sue Budarick for her technical assistance during the year.

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