3.4.2 Enhanced phosphorus fertiliser efficiency in wheat - Dunkeld, Vic

Location:
Dunkeld Research Site.

Funding:
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Rainfall:
Avg. Annual: 687
Avg. G.S.R.: 536
2009 Total: 562
2009 G.S.R.: 489

Variety: Derrimut

Sowing rate: 75 kg/Ha

Fertiliser:
70 kg/ha Granulock® SuPreme Z®

Plot size: 20 m x 1.75 m x 4 reps.

Measurements:
- Dry matter at DC41
- Grain yield, protein and screenings

Soil Type: Brown sandy clay loam

Soil test (0 – 10 cm):
NH4-N = 80 mg/kg
Organic carbon = 4%
PBI = 180
KCI-40 S = 19
NO3-N = 99 mg/kg
Colwell P = 44 mg/kg
pH = 5.6

Tillage type: Zero

Diseases:
Severe stripe rust was evident from flag leaf emergence onwards. Waterlogged conditions prevented the application of foliar fungicides.

Take home messages:
- The trial showed up to a five-fold increase in dry matter at DC41 when 20 kg/ha of phosphorus was applied. This translated into a doubling of yield, despite waterlogging and stripe rust at the site.
- A low rate of P (5 kg P/ha) did not provide a statistically significant yield response while higher rates (10 and 20 kg P/ha) did.
- Soils continue to be highly responsive to phosphorus even at higher Colwell P levels.
- There is some evidence of adequate phosphorus nutrition improving grain quality (screenings) through earlier maturity.

Background/Aim:
Phosphorus (P) response in wheat crops in south western Victoria is well documented with at least 17 individual trials reported by Southern Farming Systems from 1998-2007.

While significant and profitable phosphorus responses were recorded in most of these trials, it is still accepted that phosphorus fertiliser is used inefficiently by crops in the year of application. Typically only 10 – 30% of phosphorus fertiliser is removed in grain in the year of application, although it is now accepted that much more of a single application will ultimately be removed in subsequent years.

This poor efficiency in the year of application coupled with a rising cost trend for phosphorus has raised interest in discovering more effective means of applying phosphorus to the soil or more efficient phosphorus products.

It is proposed that phosphorus efficiency might be improved in a range of ways, such as:
- applying phosphorus in a liquid form rather than as a granular fertiliser.
- using sequestering agents to protect phosphorus fertiliser from ions that it might adversely react with.
- compounding phosphorus fertiliser with other nutrients to improve overall uptake efficiency.
- chemically/biologically inhibiting soil processes to alter the root environment in a way that favours uptake of phosphorus.

The aim of this experiment was to assess the ability of some of the above techniques to significantly improve phosphorus fertiliser response.

Treatments:

Product	Description
MAP	Mono ammonium phosphate
DAP	Di ammonium phosphate
AVAIL	A treatment for P fertiliser that "sequesters" ions that are likely to "tie up" P
ENTEC®	The nitrification inhibitor DMPP
humic acid	Degraded bio-molecules made up a large portion of the dark matter in humus
MAP + sulphur	A range of products where MAP is combined with sulphate and/or elemental sulphur

Table 1: Dry matter responses to phosphorus fertilisers at DC41

Treatment	P rate kg/ha			
	0	5	10	20
Control	553			
DAP				1982
MAP		1437	2078	2573
MAP + AVAIL		1350	1375	2147
MAP + ENTEC				2270
MAP + humic acid				2229
MAP + sulphur (four products tested)				1787 - 2435
lsd	**609.6**			
F pr.	**<0.001**			
cv	**19.2%**			

Results and discussion

The large dry matter differences observed at DC41 in response to phosphorus rates (Table 1) carried through to grain yield.

When MAP treatments were considered, there was no significant yield responses to 5 kg P/ha, but there was a significant response to both 10 and 20 kg P/ha treatments. Notably, 20 kg P/ha gave a significant yield response compared to both 5 and 10 kg P/ha treatments, suggesting that the site was highly phosphorus responsive and that additional phosphorus applications up to at least 20 kg P/ha would be profitable.

When the Colwell P level in the soil (44 mg/kg) is considered, this is consistent with the analysis of Walker (2008), which showed an average yield increase of 0.71 t/ha in wheat where an average of 21 kg P/ha was applied to wheat in soils with a mean Colwell P of 43 mg/kg.

These responses were achieved despite serious waterlogging experienced through late winter and early spring, as well as evidence of stripe rust at flag leaf emergence. Based on these results, it may be argued that the more rapid establishment where phosphorus was adequate may have helped the crop partially offset the effects of water logging, although yield was less than half of the estimated water limited potential.

Table 2: Yield t/ha and protein (%) at Dunkeld 2009

Treatment	P rate kg/ha			
	0	5	10	20
Control	1.23 (12.1)			
DAP				2.54 (11.0)
MAP		1.73 (11.8)	2.01 (12.1)	2.79 (11.3)
MAP + AVAIL		1.34 (11.7)	1.97 (11.3)	2.88 (11.4)
MAP + ENTEC				2.17 (11.3)
MAP + humic acid				2.82 (12.0)
MAP + sulphur (four products tested)				2.12 – 2.78 (10.7 – 11.1)
lsd	**0.704 (0.80)**			
F pr.	**<0.001 (0.007)**			
cv	**18.6% (4.2)**			

The other part of the experiment was an assessment of a range of alternate phosphorus fertilisers. The four MAP + sulphur products gave no responses, most likely due to adequate soil sulphur levels. No responses were observed for the other products tested.

One other notable observation from this trial was that 20 kg P/ha provided a significant reduction in wheat screenings. While the reason for high screenings in the control treatment is open to speculation, it could be argued that it resulted from heat at flowering. It is well accepted that adequate phosphorus nutrition will bring forward maturity, in this particular case reducing the impact of the near heatwave conditions experienced in the first half of November (nine consecutive days of more than 30°C).

Table 3: Screenings (%) at Dunkeld 2009

Treatment	P rate kg/ha			
	0	5	10	20
Control	8.2			
DAP				5.0
MAP		5.9	8.3	4.6
MAP + AVAIL		8.4	5.1	4.0
MAP + ENTEC				6.4
MAP + humic acid				6.1
MAP + sulfur (four products tested)				3.9 – 5.1
lsd	**2.42**			
F pr.	**0.003**			
cv	**25.5%**			

Summary:

The take home message from this trial is that this particular soil is highly phosphorus responsive to at least 20 kg P/ha, while the response to 5 kg P/ha was not significant.

To fine tune economic returns from phosphorus it is recommended that future work focuses on determining optimum phosphorus rates.

References:

Walker, C.N. (2008). The phosphate challenge. GRDC grower update, Lake Bolac, August 2008.

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