Responses of different crops to fluid phosphorus

Simon Craig, *BCG*

The objective of this trial is to determine whether responses 'to liquid P, found in wheat are the same as those found in barley, canola, oats and lentils.

Take home messages

- *Significant increases in dry matter at GS30 were found in wheat. Fluid P increased dry matter from the control by 49%, whereas only 19% increase was found when P was supplied as a granule*
- *There was an increase in dry matter from the application of P for both Barley (20%) and Oats (35%). There was no difference in dry matter between the granular and fluid products.*
- *There was no difference in terms of grain yield from P application compared to the control of each crop type.*
- *2008 is a year to apply P where required and make potential savings where it is not.*

Background

Phosphorus, unlike nitrogen, can only be applied economically at sowing time. This is because P encourages root growth which predominately occurs during the first six weeks of growth. It is during this time that plants will take up all the P it requires. Enhanced root production in the first six weeks of growth usually promotes crop growth and subsequently early dry matter responses are usually observed.

In 2005, wheat produced 80% greater dry matter at the end of tillering (GS30) than the control when fluid was applied at 12kg P/ha, whereas the granular product of the same formulation only produced a 20% increase. Other studies have shown similar results with increases in dry matter, although nearly all the studies have failed to find significant differences in terms of grain yield in wheat. Wheat in the Mallee is not a prolific tillering crop like barley or oats but the response of different crop types to fluid fertilisers is unknown.

The potential increase in whole farm profitability through the use of fluids should be determined by the potential gains in all crops grown in the region. For example, if fluids only result in greater root and dry matter production then there could be significant benefits for hay production and potentially greater N fixation from legumes.

This trial is designed to investigate whether other crops typically grown in the Mallee respond differently to that of wheat when using fluid phosphorus.

Method

Location:	Birchip	
Replicates:	Four	
Plot Size:	2m × 20m	
Crop:	Wheat (c.v. Yitpi), Barley (c.v. Vic Sloop), Oats (c.v. Wintaroo), Canola (c.v. Bravo) and Lentils (c.v. Nugget)	
Previous crop:	Fallow	
Sowing date:	25 May 2007	
Seeder:	Cone Seeder – no till, narrow points, press wheels, 20.2cm row spacings (8-inch)	
Herbicide:	25 May	Roundup PowerMax (2 L/ha) Hammer (50 ml/ha)
	23 June	Lemat (100 ml/ha)
	20 July	Select (250 ml/ha) ***(Lentils and Canola only)*** + Hasten 1% v/v and Ammonium Sulphate
	20 July	Altantis (330 ml/ha) ***(Wheat only)*** + Hasten 1% v/v and Ammonium Sulphate
Soil type:	Mallee clay loam with moderate subsoil constraints	
Soil pH:	Topsoil 8.6 (H_2O)	
Colwell P:	24ppm	

Table 1. List of treatments used in this trial.

Treatments	Crop Type	P rate (kg P/ha)	Application method
Control	Wheat	0	
MAP	Wheat	3	Banded
TGMAP	Wheat	3	Dribble Band
MAP	Wheat	6	Banded
TGMAP	Wheat	6	Dribble Band
Control	Barley	0	
MAP	Barley	6	Banded
TGMAP	Barley	6	Dribble Band
Control	Oats	0	
MAP	Oats	6	Banded
TGMAP	Oats	6	Dribble Band
Control	Canola	0	
MAP	Canola	6	Banded
TGMAP	Canola	6	Dribble Band
Control	Lentil	0	
MAP	Lentil	6	Banded
TGMAP	Lentil	6	Dribble Band

Fertilisers

- Mono-ammonium Phosphate, MAP (N10-P22-K0-S1): a commonly used fertiliser in the Mallee (granule).

- Technical Grade Mono-ammonium Phosphate, TGMAP: same formulation as MAP but mixed with water before application (fluid).

The treatments listed in Table 1 were applied in two ways; TGMAP (fluid) in a dribble band (a continuous stream of liquid behind the tyne with a water rate of 320 L/ha) and the MAP (granule) banded with the seed.

Nutrition

Measurements

Plant counts were recorded at the 2-3 leaf stage of the crop. At GS30 (end of tillering), tiller counts and dry matter production were recorded. Total P uptake was also measured using ICP-AES analysis of the whole shoots (at GS30). Head counts were taken at anthesis and the crop was harvested on 15 November. Hand cuts were taken pre-harvest to determine the harvest index for all treatments. Harvest index is a measure of the percentage of grain produced in proportion to the dry matter at the time of harvest.

Results

Table 2. Responses in wheat production from the addition of P.

Wheat	Plants counts (m^2)	Tiller counts (m^2)	Early dry matter (kg/ha)	Total P uptake (kg P/ha)	Yield (t/ha)
Control	172	409	469	1.53	1.7
MAP (3kg P)	151*	468	553	1.96*	1.8
MAP (6kg P)	169	429	560*	1.87*	1.8
TGMAP (3kg P)	174	510*	624*	2.15*	1.8
TGMAP (6kg P)	161	466	700*	2.50*	1.8
Significant Difference	**S**	**S**	**S**	**S**	**NS**
LSD (P<0.05)	**15.6**	**60.8**	**86.4**	**0.28**	
CV %	**4.25%**	**6.7%**	**7.3%**	**5.9%**	**6.8%**

Table 3. Responses in barley production from the addition of P.

Barley	Plants counts (m^2)	Tiller counts (m^2)	Early dry matter (kg/ha)	Yield (t/ha)
Control	124	462	1364	2.3
Granular (6kg P/ha)	130	459	1620	2.4
Fluid (6kg P/ha)	122	495	1657	2.5
Significant Difference	**NS**	**NS**	**NS**	**NS**
LSD (P<0.05)				
CV %	**5.2%**	**5.3%**	**17.6%**	**20.6%**

No differences were observed in the canola and lentils plots by the start of August and due to the seasonal conditions, both crops failed to produce any credible yield data. Nodulation scoring did occur in the lentils treatments in late August. A large number of active nodules were found on all treatments and no differences were observed. Soil nitrate was measured at the end of the season but the results had not been received at the time this article was written.

Table 4. Responses in oats production from the addition of P.

Oats	Plants counts (m^2)	Tiller counts (m^2)	Early dry matter (kg/ha)	Yield (t/ha)
Control	274	558	1691	1.5
Granular (6kg P/ha)	295	685	2269*	1.7
Fluid (6kg P/ha)	285	679	2307*	1.7
Significant Difference	**NS**	**NS**	**P<0.05**	**NS**
LSD (P<0.05)				
CV %	**3.0%**	**16.8%**	**10.2%**	**20.1%**

Note: *(*) indicates that the treatment is either significantly less or greater than the control.*

Interpretation

The Birchip site, despite having a starting Colwell P of 24, was responsive to P additions. Figure 1 shows the increase in dry matter as a result of the P applications. Regardless of rate, the granular treatment only increased the dry matter by just under 20 percent compared to the control. Both the fluid treatments significantly increased dry matter by 33 percent and 49 percent respectively. This appears to be incremental, and if higher rates were used in this experiment then it could be assumed that this increase may have continued slightly before it reaches its plateau.

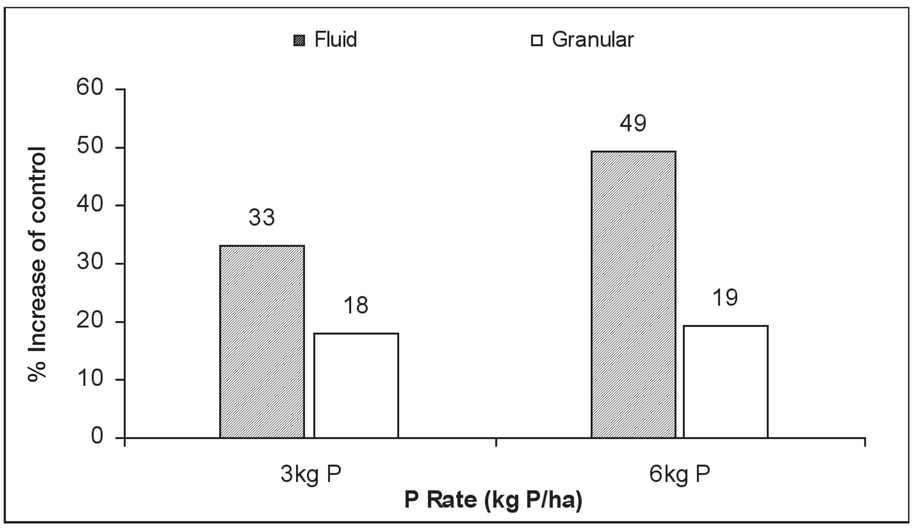

Figure 1. Increases in wheat dry matter (at GS30) from phosphorus applications expressed as a percentage of control.

Early vegetative responses to phosphorus applications were found in both barley and oats but there was no difference between fertiliser products.

In all circumstances, these increases in dry matter at GS30 did not translate into grain yield. It is uncertain why these differences do not get carried through to the grain yield. The demand from the increased biomass could reduce the yield increase through the consumption of stored moisture early in the season, placing a greater emphasis on an average to wet finish. During the season, the site had received below average rainfall from June to November. After June only 56mm rainfall was received for the rest of the growing season, of which only 3.5mm in August.

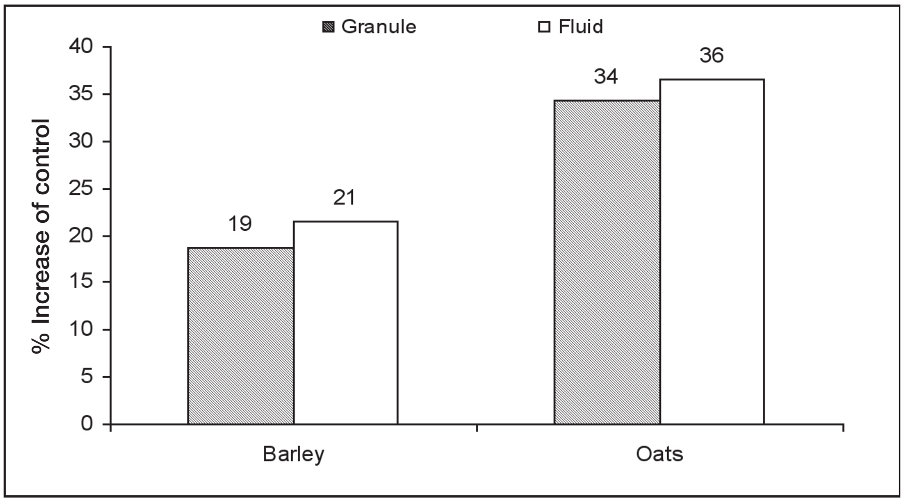

Figure 2. Dry matter production (at GS30) of both barley and oats from fluid and granular P.

Although there is no significant difference recorded, in terms of grain yield, from any application of P in all crop types there does seem to be an increasing trend, especially in Barley and Oats. Variation within the plots and treatments were observed which could be a reflection of the season. This could explain the variation within the treatments which is shown by the high co-efficient of variation (c.v%) of 20% for both barley and oats. Usually for trial work this figure should be below 10%.

There was no disadvantage in grain yield from the application of P fertilisers, which is consistent with other trials.

Commercial Practice

While the price of granular MAP is set to reach at least $1100/t ($4.40/kg P) by May 2008, the price of fluid fertilisers such as phosphoric acid (PA), at $1000/t (81% H3PO4) has become comparable ($3.90/kg P).

Currently the changeover cost to a fluid system is around $20,000-30,000, which will vary depending on the size of the seeder. To make a fluid system profitable and comparable to granular products, P rates have to be at least half the rate used normally. Below is a scenario designed to highlight the potential for fluids to fit into the Mallee given current prices hold true.

If the normal rate of granular P is 8kg P/ha, then PA can be applied at 4kg P/ha. If 1000ha is fertilised, then 8000kg of P will be required, equating to $35,200. If phosphoric acid is used at half the P rate, then only 4000kg P is required, totalling $15,600. At these prices, after two years, the changeover costs have essentially been recovered through the saving.

Based on this data only, there was no benefit in applying either form of phosphorus. However, this does not mean responses to either form of P would not have been greater if there was a different finish to the season. Further work is required before farmers invest in new fertiliser technology, especially for phosphorus, and where soils are responsive or not. For 2008, the best investment into fertiliser management is to undertake a soil test of most, if not all, paddocks. For phosphorus, a Colwell P test costs less than a $1/ha but the information gained could save you thousands!