Optimising Phosphorus fertiliser rates on alkaline soils

The aim of this replicated trial was to investigate phosphorus use efficiency in six crop types - barley, wheat, canola, lentils, faba beans and field peas. This is the third year of this BCG research.

Summary
Phosphorus response trials were undertaken on barley, wheat, canola, lentils, faba beans and field peas at four sites across the Wimmera and Mallee over the past three seasons.

There was no consistent response to the rate of phosphorus applied in wheat, barley, canola, lentils and field peas on sites that had a good fertiliser history (a positive P balance) and good P fertility (Colwell P of 15ppm or more). Faba beans were the exception responding to higher rates of phosphorus (up to 18 kg P/ha) – this was a consistent result over the 2000 and 2001 seasons.

At the Donald sites, phosphorus rate significantly increased yield. This result was not unexpected as the trials were typically located on soils that were low in fertility (Colwell P <12ppm) and acidic (pH_{water} = 6.3).

Reducing phosphorus inputs to between 6 and 12 kg P/ha will not compromise short-term soil fertility and crop production on sites with good fertiliser history and soil P fertility but further research needs to be conducted investigating the long-term implications of this strategy.

Refer to the 1999/00 and 2000/01 Crops and Pasture Production Manuals for further discussion on this topic.

Background
Most crops only recover 20-30% of the fertiliser phosphorus applied during the year of application. The recovery percentage is influenced directly by factors such as plant type, soil type, phosphorus source, soil moisture content, soil pH, phosphorus status of the soil and time of application. The 70-80% of applied P, not utilised by the crop under which it is applied, becomes residual soil P and will become available to subsequent crops over time.

The BCG, in conjunction with the Avon-Richardson Cropping Group, has endeavoured to address the issue of crop response to applied phosphorus on highly alkaline soils of the Wimmera/Mallee over the past three years. The following is a summary of the findings.

Methods
Phosphorus fertiliser response trials were undertaken in the central Mallee, southern Mallee, Wimmera (Rupanyup 2001, Charlton 2000, 1999) and Donald over three seasons from 1999 to 2001.

At each site five crops were grown – barley, wheat, canola and two pulse crops (depending on location they were lentils, faba beans and field peas).

Five rates of phosphorus were applied (0, 6, 12, 18 and 24 kg P/ha). In 1999/00, P was applied in the form of Triple Superphosphate. In 2001, a base rate of 6 kg P/ha as MAP was sown and Triple Superphosphate was added for treatments requiring higher P rates –this was in response to fertiliser solubility concerns. A sixth treatment of 12 kg P/ha all in the form of MAP was included representing farmer practice in 2001.

Plant counts were conducted for all treatments and plots were harvested for yield, protein and screening results.

All trials were conducted using a fully replicated randomised block design.

Table 1: Soil type and nutrient profiles for the 2001 sites.

Location	Soil Type	Soil pH (water)	Soil P (Colwell ppm)	5 year P balance (kg/ha)*
Birchip - cereals	Mallee clay loam	8.4	17	+ 14
Birchip – pulses and canola	Mallee clay loam	8.6	17	+ 6
Woomelang	Sandy loam	7.5	33	+ 8
Rupanyup –cereal & canola	Grey cracking clay	7.8	47	+ 38
Rupanyup – pulses	Grey cracking clay	8.1	34	+ 21
Donald	Red duplex clay loam	6.3	12	0

* P balance = P input (P fertiliser) – P export (grain yield)

Soil type and nutrient profiles for the 1999 and 2000 sites can be seen in those editions of the BCG *Wimmera/Mallee Crop and Production Manual.*

Results

Over three seasons, at a total of 12 locations, significant responses to P applications have not been seen in cereal, canola or pulse crops with exception of the following:

- Faba beans have consistently responded to higher rates of applied P (18 kg P/ha). Refer Table 3.
- At the Donald site where wheat (2000 and 2001) and barley (2001) showed a significant response to P applications (acidic soil with poor P fertiliser history).

Table 2 and 3 present a snap shot of results for two crops – wheat and faba beans – over the past three seasons. The wheat results are indicative of those seen in barley, canola, lentils and field peas.

Table 2: Yield response in **wheat** to applied P over three seasons (1999-2001) (6→12 = response achieved by increasing from 6 kg P/ha to 12 kg P/ha).

	Central Mallee	Southern Mallee	Wimmera*	Donald
2001	No response	No response	No response	0→6→12→18/24
2000	18 → 24	No response	No response	0 → 6
1999	No response	No response	No response	No response

* Wimmera locations – Rupanyup 2001, Charlton 1999 & 2000

Table 3: Yield response in **faba beans** to applied P over three seasons (1999-2001) (6→12 = response achieved by increasing from 6 kg P/ha to 12 kg P/ha).

	Southern Mallee	**Wimmera***	**Donald**
2001	12 → 18	No response	0→6, 6→18, 12→24
2000	Not trialed	Not trialed	0→6, 12→18
1999	Not trialed	Not trialed	0→6, 12→18

* Wimmera locations – Rupanyup 2001, Charlton 1999 & 2000

Grain quality did not appear to be significantly effected by P application rate for any crop type over the three seasons 1999 – 2001.

Interpretation

The consistent nature of these results over three years indicate that responses to phosphorus applications above 6 kg P /ha will be marginal on soils with good soil fertility (>15 ppm Colwell P) and fertiliser histories (a positive P balance). Faba beans were the only crop type that did not fit with this finding. Faba beans expressed yield responses at higher rates of phosphorus (18 kg P/ha).

Phosphorus rate significantly affected yield at Donald during 2000 and 2001. This result was not unexpected on soils that were low in fertility (Colwell P <12ppm) and acidic (pH_{water} = 6.3).

Commercial Practice

Trial work conducted by the BCG over the past three years indicates that economic responses generally can not be expected from high applications of phosphorus fertiliser (>12 kg P/ha) on the alkaline soils of the Wimmera/Mallee. This applies when paddocks have been reasonably well fertilised over the last five years and have a soil status above Colwell P of 15ppm.

Reducing phosphorus inputs will not compromise short-term soil fertility and crop production but further research needs to be conducted investigating the long-term implications of this strategy.

The best guidelines for making a P fertiliser decision are:

- P balance – audit P inputs (fertiliser) against P exports (grain). If a paddock has a positive balance of 20 kg P/ha or more in the last five years it is well fertilised
- Soil tests – if the soil test indicates Cowell P of 15ppm or more the soil has sufficient phosphorus reserves
- Total expenditure – if expenditure on P fertiliser is above 10-12% of total farm income then this should be reviewed (taken from FM500 farm performance analysis).