Optimising phosphorous fertiliser rates

SUMMARY

Phosphorous fertiliser is rapidly fixed into unavailable forms after sowing when the soil wets up in winter. There were no phosphorous fertiliser responses in a wide range of crops on sites with good fertiliser histories. At the Donald site, which has a poor fertiliser history, the phosphorous responses were significant, especially for the pulse crops, less for barley, and none for wheat.

It is estimated that at least 80% of the phosphorous applied, as fertiliser, is unavailable to plants. The most commonly used granulated fertilisers (DAP, MAP, double super etc) are water-soluble. After sowing, when the soil becomes wet, the fertiliser granules attract water from the soil and the soluble phosphorous in the granule dissolves. The dissolved phosphorous moves into the soil and some becomes available for plant uptake, but most of it reacts rapidly with compounds such as calcium (also iron and aluminium). Once dissolved phosphorous reacts with calcium, it becomes insoluble and unavailable. These compounds are broken down over time through chemical and biological means and the phosphorous is slowly released. Mallee soils have high calcium levels so a large amount of the phosphorous applied is unavailable for plants. Fro this reason it is best to drill seed and fertiliser together, rather than spreading the fertiliser prior to sowing.

Different crops respond to phosphorous uptake in different ways. For example, chickpeas secrete an organic acid from their roots. This acid dissolves unavailable phosphorous (bound to calcium compounds) and makes it available to the plant. Therefore chickpeas rarely benefit from the additions of phosphorous fertilisers at sowing because the crop can survive quite well on the phosphorous applied in previous years.

The BCG in their previous trial work and also in reviewing other trials carried out in the region have noticed inconsistencies in relation to phosphorous requirements for different crops grown on different soil types with different paddock histories. The BCG has set up a long-term phosphorous trial to investigate the responses of phosphorous fertiliser at a range of sites on five different crops. The trial will continue for three years, this report deals with the results of the first year.

METHOD

Phosphorus fertiliser response trials were undertaken at four sites: Birchip, Sea Lake, Charlton and Donald (Avon-Richardson Cropping Group).

Table 4.1 Soil characteristics for all site locations

Location	Soil type	Soil pH (in water)	Soil P (Colwell ppm)	Five year P balance (kg/ha)#
Birchip	Mallee clay loam	8.3	31	+30
Sea Lake	Sand	7.0	29	+26
Charlton	Red brown earth	6.6	26	+36
Donald	Medium clay	6.7	14	0

P balance is calculated by difference between P input (fertiliser) and P export (in grain)

Triple super was sown at varying rates with each crop to correspond to 0, 6, 12, 18 and 24kgP/ha. The trial was sown in a replicated design. Each site had five of the following crops: wheat, barley, canola, lentils, faba beans, lupins and field peas.

RESULTS

Birchip: There was no significant effect of phosphorous rate on the yield of wheat, barley, canola, lentil and field pea. Average yields were wheat 3.1, barley 2.9, canola 1.4, lentils 0.6, and field peas 0.9t/ha. There were no significant effects of phosphorous rate on protein and screenings in wheat and barley, and oil in canola.

Sea Lake: There was no significant effect of phosphorous rate on the yield of wheat, barley, canola, lentil and field pea. Average yields were wheat 3.2, barley 3.3, canola 1.1, lentils 0.7, and field peas 1.0t/ha. There were no significant effects of phosphorous rate on protein and screenings in wheat and barley, and oil in canola.

Charlton: There was no significant effect of phosphorous rate on the yield of wheat, barley, canola, lupins and field peas. Average yields for each crop were wheat 4.7, barley 3.3, canola 2.0, lupins 1.5, and field peas 1.3 t/ha. There were no significant effects of phosphorous rate on protein and screenings in wheat and barley, and oil in canola.

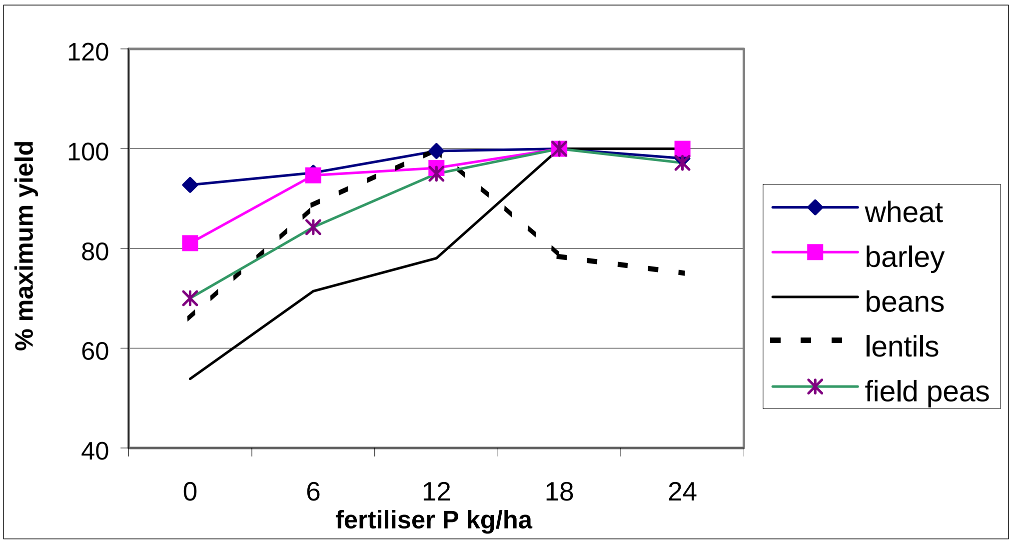
Donald: There was no significant effect of phosphorous rate on the yield of wheat, but there was for barley and the pulse crops (faba beans, lentils and field peas) (see Table 4.2).

Table 4.2 Yield response to increasing P fertiliser rates at Donald

Fertiliser applied	Yield (t/ha)				
kgP/ha	Wheat	Barley	Beans	Field pea	Lentil
0	1.91	1.67	0.47	0.98	0.58
6	1.96	1.95	0.65	1.18	0.78
12	2.05	1.98	0.71	1.33	0.88
18	2.06	2.06	0.92	1.40	0.69
24	2.02	2.07	0.91	1.36	0.66
Significant difference	**NS**	**$P<0.05$ LSD=0.25**	**$P<0.001$ LSD=0.16**	**$P<0.05$ LSD=0.23**	**$P<0.05$ LSD=0.15**

In barley, lentils and field peas, 90% of maximum yield was obtained with phosphorous rates of between 6 and 12 kgP/ha. Only in beans, maximum yield was obtained between 12 and 18 kg P/ha (see Figure 4.1). For lentils, yields actually dropped at high phosphorous rate inputs. The same negative effect occurred at both Birchip and Sea Lake. The negative effect of high phosphorous rates on lentils may be due to fertiliser toxicity. Alternatively, it may be due to early rapid growth that dried out the soil profile and in a dry season with insufficient rainfall the crop could not finish.

Figure 4.1 Relative response to phosphorous fertiliser as a % of maximum yield obtained (at Donald)



INTERPRETATION
Where soil test results indicated Colwell P was greater than 15ppm (Birchip, Sea Lake and Charlton) there were no phosphorous fertiliser responses for any of the crops in the trial. This is a surprising result especially at Charlton where the wheat yields were in the range of 4.7t/ha and some yield response to phosphorous fertiliser would have been expected. At the Donald site Colwell P was 14ppm there were good responses to phosphorous fertiliser in the pulse crops, a small response in barley and no response in wheat.

In 2000 and 2001 these trials will be repeated in each area. By the end of 2001 we should have good response curves to phosphorous fertiliser for each of the major crops grown.

COMMERCIAL PRACTICE
Fertiliser costs are a major component of the total input costs on farm. In general, the input in fertilisers has risen more on cropping farms than any other input. These trials and others undertaken in the region are indicating that phosphorous fertiliser responses are small on most paddocks with a good fertiliser history. As most of the phosphorous fertiliser is not available to the current crop, it is the background phosphorous level that provides the crop with most of its phosphorous needs. If a paddock has been reasonably well fertilised over the last five years it is not necessary to keep supplying high rates (15kgP/ha or more) every year.

The best guidelines to making a fertiliser rate decisions are based on:

- **Phosphorous balance** – if there is an excess of more than 20kgP in the five year phosphorous balance, then the paddock is well fertilised.
- **Soil test** – a soil test with more than 15ppm Colwell appears to be a good standard.
- **Total expenditure** – FM500 analysis has shown that an average annual expenditure on fertilisers, over five years, of 12% of total farm income is a good benchmark which, if exceeded does not appear to lead to improved yield.

Note: The above discussion on phosphorous rate applications applies to alkaline soils only. Acid soils appear to be more fertiliser phosphorous responsive.