Long-term Phosphorus Trial

Aim

To identify the most economical rate of phosphorus usage in a southern Mallee cropping system over time. This trial was carried out between 2003 and 2005.

Summary

- The application of P improved the yield (especially barley) and soil P content (Colwell P).
- Soil P balance doubled when high P rates were applied.
- Responses to P applications above 6kg P/ha are rare and extra expense would not be justified in the Mallee.

Background

Phosphorus (P) is an essential component of cell membranes and is important during the cell division stage of early plant growth. Consequently, phosphorus fertilisers have become a major input in many Australian cropping systems costing between 8-15% of total farm income.

While it is well established that P is an essential element for crop growth, previous BCG results have indicated that grain yield responses to granular P fertilisers were variable and that granular P fertilisers were unlikely to produce a yield response even at Colwell P levels less than 25ppm on highly alkaline Mallee soils. In response to such work, BCG established a long term P trial in 2003 to determine the most economic use of P fertilisers. This trial will continue through until 2007.

The reason for the lack of response might be explained by the highly alkaline nature of Mallee soils, which tend to have a high capacity to fix P and consequently a high proportion remains unavailable to the crop. Work currently being undertaken in the region by DPI and BCG with liquid P will help in gaining a better understanding of the mechanism of P fixation and release on alkaline soils.

Australian soils are naturally low in plant available P – a result of soils being geologically ancient and their highly weathered nature. One of the issues for P is that it often binds with soils to form compounds unusable by plants.

Methods

Replicates: 4

Plot Size: 20m x 3m

Variety: Targa (Oats)

Sowing Date: May 23 2005

Seeding Density: 70kg/ha

Herbicide: Diuron (180g/ha), MCPA500 (300ml)

Treatments: 0, 5, 10, 15, 20, 25kg P/ha

Previous paddock history includes:

2001: Chemical fallow

2002: Fallow

2003: Wheat

2004: Barley

This trial was not taken through to harvest because of a moderate level of ryegrass in the trial. Dry matter cuts were taken at growth stage at the early grain filling stage.

Results

A significant increase in DM t/ha was produced when 25kg P/ha was used (Table 1).

Table 1: DM (t/ha) of Targa Oats

Kg P applied (kg P/ha)	Dry Matter (t/ha)
0	1.6
5	1.7
10	1.5
15	1.6
20	1.5
25	1.9
Significant diff: LSD 0.05	**P<0.05 0.3**

After three years the soil P levels have produced a strong trend (Table 2). As the rate of P applied increases the Cowell P level increases significantly.

Table 2: Soil P Colwell (mg/kg) after three years.

Kg P applied (kg P/ha)	Soil P Colwell (mg/kg)
0	18.2
5	17.5
10	25.0
15	29.8
20	46.5
25	40.5
Significant diff: LSD 0.05	**P<0.05 17.9**

A significant difference in Colwell P was found between the low P rates (0 & 5kg P/ha) and high P rates (20 & 25kg P/ha).

Table 3: Long-term P yield trial results since 2003 (year 1)

Kg P applied (kg P/ha)	2003 Wheat (t/ha)	2004 Barley (t/ha)	2005 Oats (Dry Matter t/ha)
0	2.95	0.56	1.6
5	3.32	0.85	1.7
10	3.23	0.93	1.5
15	3.27	0.96	1.6
20	3.45	0.91	1.5
25	3.38	0.87	1.9
Significant diff: LSD 0.05	**NS 0.51**	**P<0.05 0.23**	**P<0.05 0.3**

Interpretation

This trial is now in its third year. P has been applied at 0, 5, 10, 15, 20 and 25kg/ha to replicated plots. The harvest results over the three years are presented in Table 3.

The trials have shown an increase in grain yield or dry matter from the 0 P to 5kg/ha P applied rate. Our trials over a number of years suggest we rarely get responses to P applications above 6kg P/ha. High rates of P will give a marginal response on soils with good soil fertility (>15ppm Colwell P) and with a fertiliser history which has a positive P balance.

The Colwell P test is not completely sound; with reports on alkaline soils finding precipitated P (fixed P) can be dissolved during the test. This would result in an overestimation of the actual available P level in the soil. This trial does not suggest this was the case although it should be taken into account when using this method only for analysis.

Commercial Practice

Trial work conducted by the BCG over several years and different sites indicate that economic responses generally cannot be expected from high applications of P fertilisers on the alkaline soils of the Wimmera Mallee. This applies where paddocks have been reasonably well fertilized over several years and have a soil Colwell P status of 15ppm or higher.

The rate of P application is dependent on crop type and yield.

Reducing P inputs will not compromise short-term soils fertility and crop production. The best guide for making P fertiliser decisions are:

- **P balance:** audit P inputs (fertiliser) against P exports (grain). If a paddock has a positive balance 20kg P/ha or more in the last 5 years it is well fertilized.
- **Soil test:** if the soils test indicates Colwell P of 15ppm or more the soil has sufficient phosphorus reserves, and
- **Total expenditure:** according to FM500 farm performance analysis, if total P fertiliser expenditure is above 8-12% of total farm income, then it needs to be revised.