Reduce P Inputs without Reducing Profitability

Report by Helen Burns (NSW DPI) on 2006-2007 study by Dr Mark Conyers (DPI NSW) at "Tandara", Morven investigating soil phosphorus responses in wheat

The phosphorus input decision

A crop's phosphorus fertiliser requirement varies with:

- Soil properties - including chemical (e.g. pH), and physical (e.g. bulk density)
- Production target
- Time of sowing
- Response curve
  i. Colwell P test
  ii. Phosphorus Buffering Index (i.e. how much P the soil will bind in an unavailable form)

How much phosphorus applied will also depend on:

- Individual financial situation - i.e. minimising inputs may be seen as a way of reducing exposure to risk.
- Opportunity cost of inputs - are there other ways to spend that money that would give a higher return on investment?

The phosphorus cycle and fertiliser requirements of wheat

1. P is present in the soil in several forms (Figure 1) broadly described as:
   i. readily plant available P (in the soil solution)
   ii. loosely bound P
   iii. organic P
   iv. bound P – within the soil clays and minerals

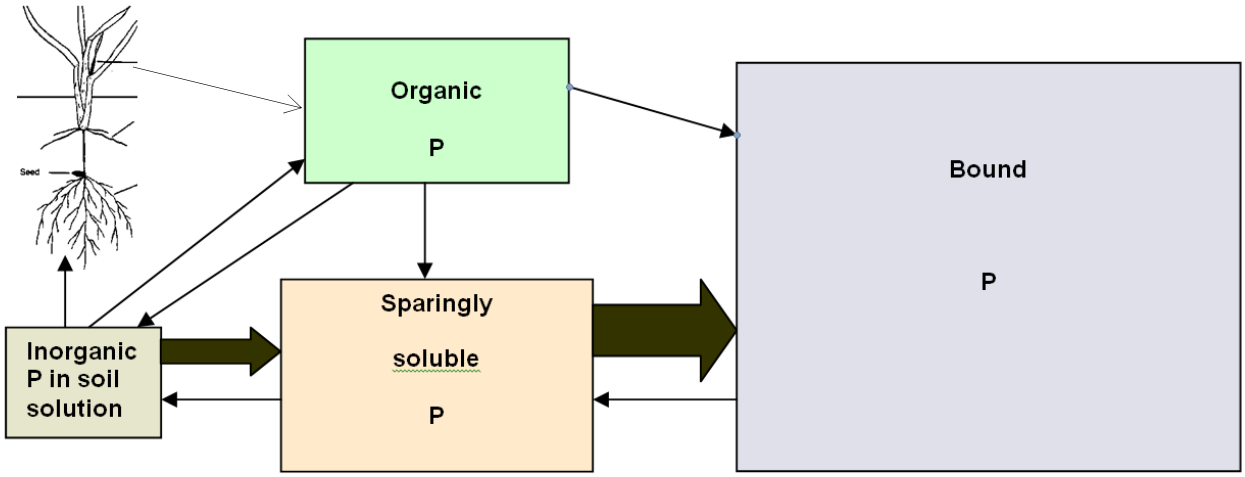
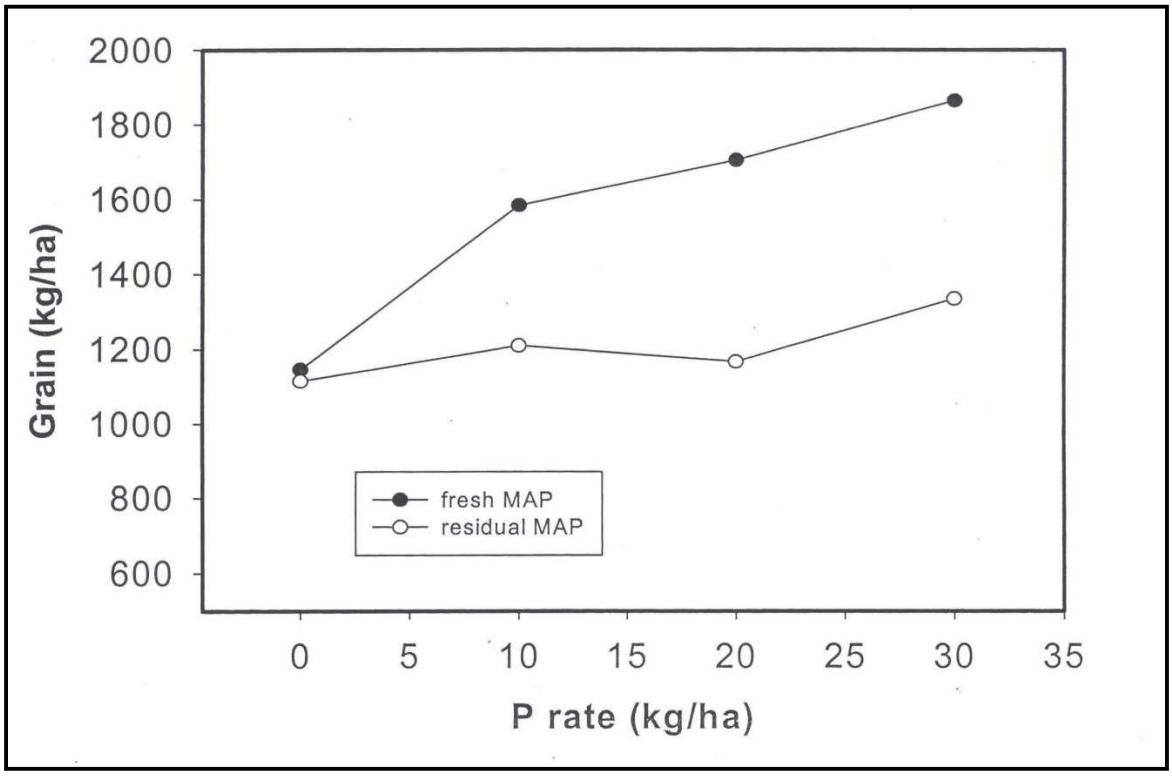


Figure 1. A simplified representation of phosphorus cycling, including the range of P pools. Note that plants can only access the inorganic phosphorus in the soil solution. *The arrows indicate the trend for phosphorus to move to the bound pool and a relatively much smaller movement to the plant available inorganic form.*

2. Most Australian soils have inadequate levels of readily available P to meet the requirements of productive agricultural crops.
3. The plant only uses inorganic P.
4. Phosphorus moves very little in the soil; therefore uptake of P will be higher for plants with vigorous, root systems that are able to explore a large soil area.
5. What soil tests tell us:
    - Colwell P test of <30 ppm - soil P level is below critical level for soils with a PBI below 140. There is likely to be an economic response to standard fertiliser rates of 15 to 20 units of P *(as a guide 4kg per each tonne of wheat grain yield)*.
    - Colwell P 40 to 50 ppm – maintenance levels of P are needed at sowing to produce a vigorous seedling, highlighted in the 2006 and 2007 trial results shown in Figure 2:
        - 30 kg/ha P will produce economic returns in a 'good season'
        - 10 kg/ha P is the better option in years when low soil moisture levels limit yield.
6. There is no response data for P nutrition research on high P soils (research has concentrated on deficient to medium range, responsive sites).
7. Use higher rates of P for late-sown crops – cold conditions limit root growth, and therefore the crops access to soil P.
8. Dual purpose (Grain + Graze) crops have a higher requirement for P (see Table 1).
9. **Always apply some P at sowing**, regardless of soil level – readily available P is essential for healthy seedling growth, and the crop continues to absorb P until after flowering (anthesis). Most unfertilised soils cannot release P fast enough to meet the demand of productive crops.



Source: Data provided by M Conyers

Figure 1. Phosphorus response curves for wheat sown in 2007 at Culcairn onto plots with residual MAP carried over from a 'failed' 2006 wheat crop and fresh MAP applied with 2007 crop. (Pre-sowing soil for Colwell P 29 ppm, PBI about 100)

Table 1. Phosphorus required for growing a wheat crop (grain & graze)

Grazing yield (tonnes dry matter / ha)	Grain yield (tonnes grain / ha)	Phosphorus required (kg / ha)
0	2	8
2	2	11
2	4	16
3	2	14
3	4	19
4	2	16
4	4	22

Source: Freebairn B (2002)

Take home messages

- Soils with high Colwell P levels can be managed to draw on P reserves, but there is no data to indicate how rapidly that P reserve will run down.
- Plants need readily available P (i.e. applied fertiliser) at sowing, even in high P soils, but there is the opportunity to reduce application rates on high P soils.
- Late sown crops are more dependent on applied P – colder and dry conditions reduce the rate of mineralisation of P. Cold conditions that occur with late sowing also affect root growth and limit the plants ability to explore the soil. (Dry conditions have the same affect on root growth).

Further reading

Freebairn B. (2002) *Productive dual purpose winter wheats*. Agnote DPI 438, NSW Department of Primary Industries. Access at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/145046/productive-dual-purpose-winter-wheats.pdf

Conyers MK and Laycock J (2009) Cost effective P and Zn nutrition. GRDC Update paper. Access at: https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2009/09/COST-EFFECTIVE-P-AND-ZN-NUTRITION

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