

UNDERSTANDING PHOSPHORUS

Soil tests in low rainfall cropping areas of SA

KEY POINTS

- Several phosphorus soil tests are now available to farmers.
- When used in-conjunction these tests can provide additional information on phosphorus levels and can be used to modify phosphorus fertiliser applications.

Phosphorus (P) is an essential plant nutrient and has been inherently low across the low rainfall cropping soils of South Australia. Large responses to phosphorus have been observed when these soils were developed for agricultural production.

When considering how much phosphorus to apply an assessment of the soil phosphorus level is important, - the levels are affected by soil type, how much phosphorus fertiliser has been applied and the phosphorus removed in products from the paddock such as grain, hay and livestock.

This fact sheets summarises the phosphorus tests available and how they can be used to determine your phosphorus requirement particularly targeting lower rainfall cropping areas of SA where low phosphorus levels are still observed. The DGT P test is a relatively new test while the Colwell P and PBI test have been available for many years.

Table 1. Categories by crop for DGT tests (Mason, Sean pers. comm and Mason et. al 2010).

Category	Wheat	Barley	Chickpeas	Canola	Lentils
Very low	0-25	0-25	0-25	0-15	0-25
Low	25-56	25-51	25-48	15-24	25-44
Marginal	56-73	51-84	48	24-46	44
High	73-100	84-100	48-70	46-60	44-70
Very High	>100	>100	>70	>60	>70

Commonly Available Phosphorus soil tests in SA

DGT Phosphorus test - readily available P in soil water solution

DGT (Diffusive Gradients in Thin-Films) phosphorus measures the diffusion supply of available phosphorus sources in the soil moving towards a receptor.

This relatively new method has been developed by Lancaster University and validated under Australian conditions by Dr Sean Mason (Agronomy Solutions) and critical levels (and ranges) for five crops have been made at this stage (Table 1).

The DGT method measures the soil water available phosphorus under field conditions and has a better relationship with yield responses than Colwell P, particularly on alkaline calcareous soils.

Colwell Phosphorus Test – easily extractable P from soil water or loosely attached to soil

The Colwell P test has been calibrated across a range of crops and soils in SA. Added phosphorus becomes attached to clay particles, organic matter and compounds of iron and aluminium and only part of this is available to plants and the Colwell P test has been developed to attempt to measure this easily extractable P.

On calcareous soils it has been found to often over- estimate available P as P fixed by lime is extracted (measured). Table 2 highlights general P levels however it is better used in-conjunction with the PBI test (see Table 3) conditions and has a better relationship with yield responses than Colwell P.

Table 2: General critical values (Colwell P) for cereal crops.

Available nutrient	Soil phosphorus status (ppm) Colwell P				
	Very low	Low	Marginal	Adequate	High
Crops Non-calcareous soil	<10	10-20	20-30	30-45	>45

Phosphorus buffering index (PBI)- measures the P fixing or holding ability of the soil

PBI supports Colwell phosphorus analysis by providing a measure of 'tie-up' and leaching potential.

It has been developed to measure strong tie up processes to soil elements such as iron and aluminium and strong adsorption to clay where a significant proportion of phosphorus applied will be unavailable to plants.

On calcareous soils where P becomes unavailable due to fixation with lime a higher PBI is also often observed. Higher PBI indicate a stronger potential for 'tie-up' and while a very low PBI (below 20) indicates that there may be potential for phosphorus to leach (these soils generally have low Colwell phosphorus levels as well).

Table 3 shows the relationship for critical Colwell phosphorus values for the standard PBI test. These relationships have been developed for soils in Queensland so an interpretation

category is suggested for South Australian soils (see in brackets).

Case Studies comparing tests and implications for phosphorus fertiliser rates

Examples (Table 4) are provided from real soil data collected through the Agricultural Bureau of SA Inc project through funding from the Australian Government's Future Drought Fund program. Acknowledgement is given to the contributing farmers in the Lowbank, Wunkar and Point Pass/

Robertstown branches. Some data was also used from a calcareous soil on Yorke Peninsula developed through the NLP funding soil pit project. In some cases this type of variation may occur in one paddock with different soil types.

It is recommended that the critical values are discussed with an agronomic consultant when making decisions based on test results as fertiliser rates need to be developed from a combination of projected yield, cropping intensity/ stocking rates/ removal, soil type and soil test results.

Table 3: Critical Colwell P soil test values for standard PBI categories (Gourley et.al 2007).

PBI Category (for SA in brackets)		Critical Colwell P value (mg/kg) for mid-point of PBI category (range) ¹
<15	Extremely low (very low)	23 (20-24)
15-35	Very very low (low)	26 (24-27)
36-70	Very low (low - moderate)	29 (27-31)
71-140	Low (moderate)	34 (31-36)
141-280	Moderate (moderate - high)	40 (36-44)
281-840	High (high)	55 (44-64)

¹ Critical Colwell P value (mg/kg) at the mid point of PBI category. Value in parenthesis are critical Colwell P values at the lowest and highest PBI values within the category.

Table 4: Case studies showing DGT, Colwell P and PBI

Case Studies	DGT P – µg/L	Colwell P – mg/kg	PBI	Implications for P rate
1. Lowbank – loamy sand area affected by drought with failed crops in year before sampling	112 H	15 L	14 VL	High DGT (available) P suggests considerable carryover of P from previous year therefore could reduce P rate this year. PBI low however low rainfall last season so little leaching would have occurred.
2. Wunkar – sandy loam good area in paddock	37 L	10 VL	42 LM	Both DGT and Colwell P are low so suggest to increase P rate and should see responses in better years. PBI is high enough that P can build up. As a rough rule an extra 3kg P/ha above maintenance rate should increase Colwell P by 1 mg/kg.
3. Calcareous sandy loam YP Urania	33 L	73 H	246 MH	High Colwell P is misleading as a calcareous soil (31% carbonate) and carbonate is fixing P (PBI high) as shown by low DGT P. Fertilise for the current crop requirements on a calcareous soil. Note there is a current GRDC project examining calcareous soils and improving nutrition.
4. Clay loam Robertstown west intensively cropped	119 H	40 H	43 LM	High Colwell and DGT P with moderate retention value suggesting P rate could be dropped to maintenance level (removal + fixation) without any yield penalty.
Broad targets for wheat	>56-73	>30	20-140	

VL – very low, L – low, LM – low to moderate, MH – moderate to high, H – high.

This fact sheet was prepared by Brian Hughes and Andrew Harding PIRSA-SARDI.

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References

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