NOVEMBER 2012

GRDC
Grains Research & Development Corporation
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CROP NUTRITION FACT SHEET

SOUTHERN REGION

PHOSPHORUS MANAGEMENT

Phosphorus (P) fertiliser represents a substantial input cost in southern cropping systems. Soil testing provides an understanding of your fertility profile and is a vital step in making informed fertiliser decisions.

KEY POINTS

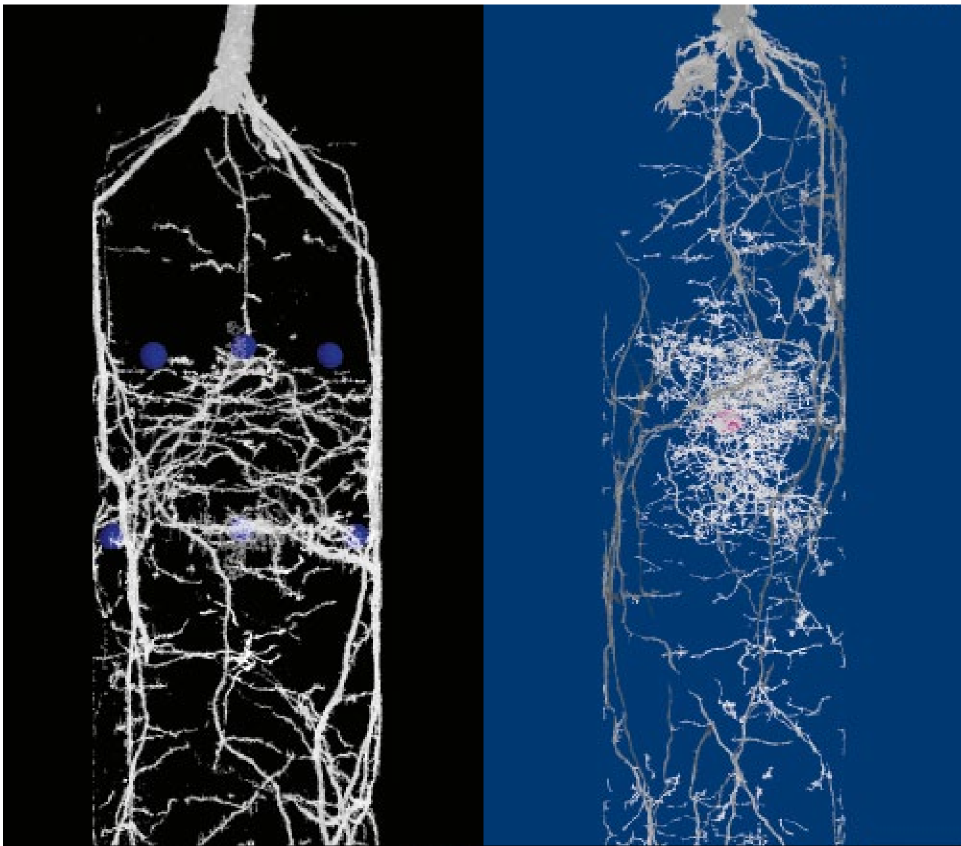
- After decades of consistent phosphorus (P) application, many soils in the southern region now have adequate P reserves.
- Before deciding on any fertiliser strategy, use soil testing to gain a thorough understanding of the nutrient status across the farm.
- If soil reserves are sufficient, there may be an opportunity for growers to save money on P fertiliser by cutting back to a maintenance rate.
- Work with an adviser to refine your fertiliser strategy.

During dry periods, such as the prolonged drought of the early 2000s, poor crop yields resulted in less P being taken to the silo than under 'normal' conditions.

As a result of this, along with high rates of P fertiliser being regularly applied, many soils in the southern grains region now have good soil P reserves.

P fertilisers are an expensive component of input costs, so it makes sense to be aware of levels in your soils and to adjust P fertiliser rates to meet your crop's immediate demands.

If a paddock has been regularly fertilised and inputs have exceeded the level of P removed in the crop, a replacement P strategy helps to better match expenditure to income.



PHOTOS: UNIVERSITY OF NEW ENGLAND (COURTESY: RICHARD FLAVEL)

3D computer-aided tomographs of cereal root systems supplied with P in a diffuse band (black) or in a granule (blue) after 30 days' growth.

Replacement rates are preferable to running P down, because the cost of building those reserves up again in the future can be high on certain soil types.

Before any major change to fertiliser strategy is made, however, it is important to use comprehensive soil testing to determine current fertility levels.

Soil testing

Soil testing regimes in use today were originally developed when the soil fertility profile was different and when conventional tillage re-incorporated crop residues and resulted in significant mixing of soil in the topsoil.

Substantial changes to farming systems – continuous cropping, stubble retention, zero/minimum tillage, higher yield potentials and a trend towards greater seasonal variability – means that testing protocols continue to evolve to be able to predict a response to P fertiliser under the new conditions.

Taking random samples of the surface soil (0 to 10 centimetres), typically from

Commercial soil tests

Colwell-P

The Colwell-P test uses a bicarbonate (alkaline) extraction process to assess the level of easily available soil P and was the original test for P response in wheat developed in NSW.

The Colwell-P level that gives maximum yields varies between soil types, but is usually in the range of 25 to 50 parts per million.

It is used alongside the phosphorus buffering index (PBI) to give an indication of the levels and accessibility of P in the soil.

PBI

The PBI indicates the availability of soil P by showing how much fertiliser P a soil can fix into unavailable forms. The buffering capacity of a soil refers to its ability to maintain its P concentration in solution as the plant roots absorb the P.

The higher the value, the more difficult it is for a plant to access P from the soil solution. PBI values of less than 100 are considered low (P is readily available) while values greater than 200 are considered high.

PBI value is unlikely to change significantly over time so it does not need to be measured on every 0 to 10cm soil sample, nor every year.

PBI and critical P level

There is a positive relationship between PBI and the Colwell-P value required for near maximum crop yield.

Desirable levels of Colwell-P may be up to 10 units higher for high PBI soils than for low PBI soils.

The Colwell-P soil test is not as accurate in predicting plant available P on the highly calcareous soils found on parts of the Eyre and York peninsulas. In these soils, alternative soil tests such as DGT may better predict crop response to fertiliser.

DGT

The DGT (diffusive gradients in thin films) test was developed because existing soil testing methods, such as Colwell-P, had been shown to be poor predictors of plant available P on certain soil types (calcareous; acidic with high iron or aluminium).

The DGT test is a plastic device that uses an iron oxide gel as a P sink, which attracts available P through a membrane.

It is deployed on moist soil (100 per cent water-holding capacity) for about 24 hours, after which the device is washed. The amount of P bound to the gel is removed by washing with a solvent, then measured.

The DGT measurement incorporates the initial soil solution P concentration, as well as the ability of the soil to resupply the soil solution pool in response to the removal of P. It is designed to mimic the action of plant roots so is a better method of predicting plant P requirements than methods based on chemical extractions, for example, Colwell-P.

Initial testing has demonstrated that DGT shows considerable promise for predicting soil available P levels on many soils used for cropping in south-eastern Australia.

The DGT test is currently available through two laboratories. See Useful Resources for details. It will become more widely commercially available in 2013.

PHOTO: TIM CONDON

Comprehensive soil testing that includes the subsoil will build a more complete picture of a soil's fertility, and can be used to refine your fertiliser strategy.

between the rows, across cropping paddocks is the best way to understand the P status of the soil and, consequently, to inform decisions about fertiliser expenditure and application rates.

Soil test results will indicate if there is likely to be a response to a fertiliser. This is the start of the process for estimating the approximate amount of nutrient required to achieve a target yield.

Along with soil testing, seek to identify different yield zones within the paddock based on yield data and personal experience, and try to determine the underlying cause of any yield variability.

For example, if subsoil constraints or different soil types are present, adjust the P fertiliser management strategy accordingly.

Analysing grain for its nutrient content can also suggest how much nutrient has been removed with each harvest. This provides an additional indication of soil fertility.

Identify responsive soils

Soil test values, along with paddock histories, will indicate which soils are likely to be responsive to P fertiliser and which will be non-responsive.

On responsive soils, take advantage of row-spacing options.

In a situation where 12 kilograms per hectare of applied P on 15 to 18cm row spacing has been recommended, the same result may be achieved with 9kg/ha of applied P if the crop were seeded on 25 to 30cm row spacing.

Calculate P needs for the upcoming crop by adding at least the losses from grain removal (3 to 3.5kg P per tonne for wheat) and straw removal if burnt or baled (around 0.5kg P/t). Plant residue from the previous crop, plus P that is permanently fixed or precipitated in soil (both of which will vary depending on soil type) can also be included.

For example, a wheat crop grown in southern New South Wales might require a maintenance rate of 10kg P/ha plus 3.5kg P/t of grain removed once yields exceed 3t/ha. Talk to your adviser to determine exact rates for your region and situation.

Adding some extra P in the crop prior to a pasture phase can also help the performance of the pasture because some of this P will carry into the next year, particularly for undersown pastures.

TABLE 1 Phosphorus removed (kg) in one tonne of grain per hectare

Crop type	Phosphorus
Cereals (wheat and barley)	2-4.5
Cereal hay	2
Cereal straw	1
Chickpeas	2.5-5
Canola	7
Sorghum	1.5-4
Maize	2.5-4
Peanuts	3-5
Sunflowers	5-9

Different plant species remove different amounts of P. Around half the net P removed will come from the subsoil, the majority from the 10 to 30cm layer. The proportion from deeper in the profile is likely to be greater in drier environments.

PHOTO: TIM CONDON

P is critical to good establishment as demonstrated by zero P on a trial site in Harden, NSW. The granite soil had a background Colwell-P of 30mg/kg, and the poor establishment is contrasted with healthy growth on either side of the test strip, where 90kg/ha MAP (18kg P) was applied.

Cereals are generally regarded as the most demanding for P fertiliser. Pulses and canola in the same situation usually require less P fertiliser to maintain productivity, mostly because they yield less. Refer to Table 1.

If there are no other impediments, such as disease, consider seeding near last year's row if the site is likely to be strongly P responsive.

For non-responsive situations, all row positions are equally acceptable for managing P.

Application

P is a poorly mobile nutrient in the soil, so placing it at or near the seed at sowing is the most efficient way to ensure it is easily available to the growing plant.

However, when placing granular P with the seed, be aware of the potential for damage to emerging seedlings. Canola in particular is sensitive to fertiliser toxicity.

Concentrations of fertiliser in the seed zone are influenced by:

- type of fertiliser;
- soil disturbance;
- air velocity in the seeder;
- ground speed;
- seeding depth;
- stubble cover;
- soil texture; and
- moisture content.

Spreading P by top dressing is highly inefficient and should be avoided. Since crop requirements for P tend to be greatest during early growth, it is essential that P management is done correctly at sowing. It is very difficult to correct mistakes later in the season.

Foliar P is not yet considered sufficiently reliable to be recommended for broadacre cropping.

Retaining large seed with high P content for next year's crop is a good way to give your crop a kick-start.

Liquid vs granular

Liquid P application is an efficient and flexible delivery method, but it has the disadvantages of requiring a separate delivery system and being expensive in comparison to granular P.

Liquid P delivers the crop's requirement at a

PHOTOS: SEAN MASON

The DGT soil test is a plastic device that attracts available P through a membrane to an iron oxide gel. After 24 hours on moist soil (100 per cent water-holding capacity) the device is washed, and the amount of P bound to the gel is measured.


PHOTO: TIM CONDON

An Incitec Pivot trial in Grenfell, NSW, shows delayed maturity in the wheat on the right-hand side, which had 10kg P/ha applied at sowing, compared to the crop on the left which had 40kg P/ha applied.

lower rate per hectare on calcareous soils. It can be mixed with other nutrients on-farm to deliver exactly the rates required for different soil types, paddocks or crops.

However, it is only on highly calcareous soils and a small number of other cropping areas where the benefits in terms of crop production outweigh the extra expense.

For example, on the upper Eyre Peninsula, 3kg/ha of liquid P for wheat will meet the crop's needs better than 10kg P/ha of granular product.

See Useful Resources for more information on fluid fertilisers.

Economics

Any P fertiliser decision should start with knowledge of the current soil P status.

Maintenance rates of fertiliser P will vary with soil test values, and targeted yield and returns.

If soil test results indicate high P reserves, there is a case for reducing rates and realising some cost savings, but this should be balanced against the potential for losing income if P rates are too low or the P is applied ineffectively.

For example, the decision to reduce P rates from 20kg/ha to 10kg/ha may result in income foregone in an average year, but of course a cost saving in a very dry year.

The best option may be to stick with the higher rates, or somewhere inbetween that fits into your budget and represents an acceptable level of risk.

Bear in mind that lost yield and income foregone also represent a loss on your other investments in the cropping enterprise – weed control, seed, fuel, time and overheads.

Many growers avoid regular soil testing because of the cost and/or the inconvenience of coring soils in summer or early autumn.

However, in the context of the whole cost of a cropping operation, strategic soil testing to better understand your farm's fertility profile and optimise your fertiliser tactics represents a sound investment.

Consult your adviser on the specific requirements of your cropping program.

Undertaken as part of the GRDC's **More Profit from Crop Nutrition** initiative.

Acknowledgements: Roger Armstrong, Mark Conyers, Sean Mason, Mike McLaughlin, Simon Speirs, Nigel Wilhelm.

USEFUL RESOURCES

Making Better Fertiliser Decisions for Cropping Systems in Australia
www.bfdc.com.au

Fluid Fertilisers
www.fluidfertilisers.com.au

DGT Soil Tests
Available at: APAL Laboratory
PO Box 327
Magill SA 5072
08 8332 0199
info@apal.com.au
www.apal.com.au

CSPB Soil & Plant Analysis Laboratory
2 Altona Street
Bibra Lake WA 6163
08 9434 4600
www.csbp-fertilisers.com.au/nutrition-services/soil-and-plant-analysis-laboratory

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GRDC PROJECT CODES

DAN00165, DAV00095, UA00103, UA00111

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