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GRDC
Grains Research & Development Corporation
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CROP NUTRITION FACT SHEET

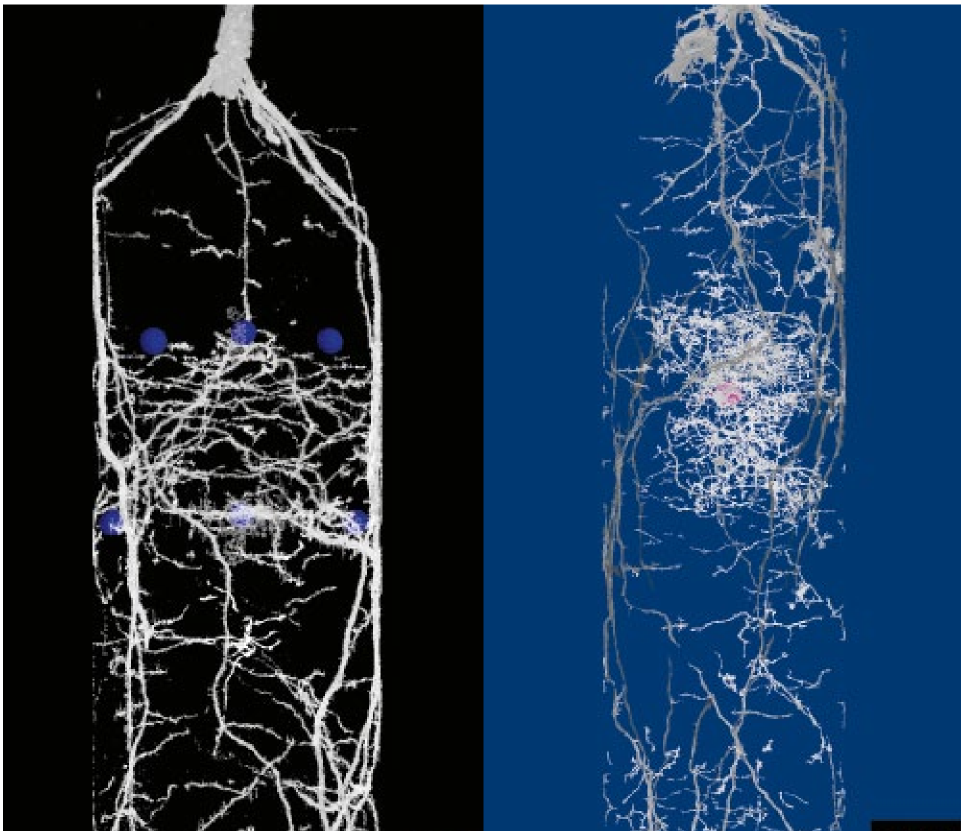
WESTERN REGION

PHOSPHORUS MANAGEMENT

Phosphorus (P) fertiliser represents a substantial input cost in western region 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 western region now have adequate P status.
- Before deciding on a fertiliser strategy, use soil testing to gain a thorough understanding of the nutrient status across the farm.
- If the soil P status is more than adequate, there may be an opportunity for growers to save money on P fertiliser by cutting back to a maintenance rate.
- Consider other factors; if pH ($CaCl_2$) is less than 4.5, the soil is water repellent or root disease levels are high, then the availability of soil test P is reduced and a yield increase to fertiliser P can occur even when the soil test P results are adequate.
- Work with an adviser to refine your fertiliser strategy.



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.

The amount of phosphorus (P) applied to a crop has historically been more than is removed at harvest – on average twice as much (see Table 1).

During the 'millenium drought' however, P use was lowered to save money. As a result of this, many soils in the western region have good soil P reserves.

P fertilisers are an expensive component of input costs, so it makes sense to know how much your soils have and to adjust P fertiliser rates to meet the crop's immediate demands.

In addition to imposing an unnecessary cost, continuing to add P at higher levels than necessary may also have environmental impacts if the excess runs off into rivers, streams or wetlands.

Results from more than 100,000 recent soil tests in the south-west of WA showed that most growers are operating at or above the soil P levels required. 85 per cent of these tests had soil P test values higher than the critical Colwell-P value needed for near-maximum crop production. Note, however, this critical value varies depending on soil type or PBI (phosporus buffering index).

In these cases, a maintenance P strategy will better match expenditure to income.

Maintenance 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. Focus on maintaining levels without risking deficiency in the 0 to 10 centimetre soil layer.

Before any major change to fertiliser strategy is made, however, it is important

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.

The Colwell-P level (0 to 10cm) that gives maximum yields varies between soil types, but is usually in the range of 15 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 (or 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.

Values of PBI less than 100 are considered low (P is readily available) while values more than 200 are considered high.

PBI value is unlikely to change rapidly over time so it does not need to be measured on every 0 to 10 cm 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.

DGT

The DGT (diffusive gradients in thin films) test was developed because existing soil testing methods, such as Colwell-P on its own without reference to PBI, 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 around 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. In this way, 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.

DGT has shown considerable promise for predicting soil available P levels on many cropping soils in south-eastern Australia, however, it is a new test, and more data is required to determine its accuracy and usefulness for the west.

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.

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
Faba beans	4
Lentils	4
Lupins	3-4
Field peas	3-4

Different plant species remove different amounts of P. Take this into account when calculating P needs for the upcoming crop.

to use comprehensive soil testing to determine current fertility levels including key properties such as pH.

Soil testing

30 to 50 per cent of WA growers conduct regular soil testing, the highest rate in the country.

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

Testing protocols have continued to evolve, to better predict a response to P fertiliser under changed farming systems.

Continuous cropping, stubble retention, zero/minimum tillage, higher yield potentials and a trend towards greater seasonal variability all represent a radical departure from the farming systems that existed just two decades ago.

Taking random samples of the surface soil (0 to 10cm), typically from between the rows, from different yield zones of cropping paddocks is one way to understand the P status of the soil and, consequently, to inform decisions about fertiliser expenditure and application rates.

Using GPS to sample the same site every three to four years is another approach.

This allows the grower to track changes in soil test P, potassium (K) and pH over time.

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

Along with soil testing, 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

The 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.

Calculate P needs for the upcoming crop by adding at least the losses from grain removal (3 to 3.5 kilograms P per tonne for wheat) and straw removal if burnt or baled (around 0.5kg P/t).

Plant residue from the previous crop, plus that P which is permanently fixed or precipitated in soil (both of which will vary depending on soil type), can also be included in the calculation of the maintenance rate.

Talk to your adviser to determine exact rates for your region and situation.

Cereals are generally regarded as the most demanding for P fertiliser, so pulses and canola in the same situation usually require less P fertiliser to maintain productivity, due mainly to their lower yields (see 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.

Some soils will be responsive to fertiliser P even when the soil test P levels show that P is adequate. This scenario can occur on water-repellent soils where the soil surface does not wet up evenly and the P present in dry patches is unavailable to the crop.

This can also occur where soil pH is low (less than 4.5 in $CaCl_2$) or where root

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.

disease levels are high due to root damage and so are not able to fully explore the soil surface layer.

Application

P is not very mobile in the soil, so placing it at or near the seed at sowing is the most efficient way to ensure it is readily available to the growing plant.

If granular P is placed with the seed, it can damage emerging seedlings. Canola and lupins in particular are sensitive to fertiliser toxicity.

On soils that have the capacity to retain P, such as the ironstone gravel soils east of the Darling Range, it is best to drill fertiliser with the seed.

Spreading P by top dressing during the growing season is highly inefficient and should be avoided, except in high rainfall areas with sandy soils. Because crop requirements for P tend to be greatest


PHOTO: MIKE WONG

Soil tests conducted by Buntine grower Stuart McAlpine showed P at double the critical levels advised by CSIRO's Mike Wong. In response to this, and to low commodity prices at the start of the 2012 season, Stuart significantly dropped the level of applied P. He switched from granular to a liquid NPK fertiliser to ensure that even at lower levels, P would be evenly distributed and therefore available to the growing plant.

during early growth, it is essential that the P management is implemented 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.

Economics

Any P fertiliser decision should start with knowing 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, depending on soil P status, the decision to reduce P rates from 20 kilograms per hectare to 10kg/ha may result in income foregone in an average year, but of course a cost saving in a very dry year.

In borderline P soils, the best option may be to stick with the higher rates, or at least choose a rate as high as your budget allows with 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 with your adviser on the specific requirements of your cropping program.

USEFUL RESOURCES

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

CSBP 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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