Can we reduce our phosphorus inputs?

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RESEARCH

Key messages

- **Reducing P inputs has a risk attached to it, but excessive use of P fertiliser is also a risk to profit making.**
- **After several seasons with high crop yields, reduced P inputs are not maintaining soil P fertility.**
- **Monitoring soil P fertility can be a cost-effective method to manage the risk associated with reduced P inputs.**

Background

Many cropping paddocks across EP are currently recording high soil test phosphorus (P) values. This suggests that there may be an opportunity to reduce P fertiliser rates in those paddocks.

To manage P more efficiently, we have asked the question 'Can we reduce our P inputs?' To investigate this, we have tested the merits of using a replacement P strategy by adding the amount of P that was removed in the previous crop and we have evaluated the residual value of previously applied fertiliser P (previous two articles). In this article we consider the risks associated with reduced P inputs and evaluate strategies that help us to manage this risk.

P fertilisers underpin productive farming systems in southern Australia. There are two main risks to the bottom line when it comes to fertiliser management, the first being loss of profit through loss of yield from too little fertiliser and second being loss of profit through use of fertiliser above crop and pasture requirements. There are several ways to monitor whether fertiliser management is at optimal efficiency and they include fertiliser response trials, modelling of the interaction between soil nutrient reserves and crop production, and the use of soil testing to monitor soil fertility. Fertiliser response trials tend to be quite accurate, but are intensive in cost and labour, and are specific to the site and season of the testing. Modelling enables consideration of response to different management strategies over a longer timeframe, but when it comes to phosphorus, it is very much a work in progress and not ready for use of on-farm prediction of soil nutrient reserves. Soil testing is a monitoring tool that predicts the responsiveness of the paddock to P addition based on the soil test value, although Colwell P on calcareous soils has some extra problems. In Figure 1 we consider the likely behaviour of P reserves in a cropping soil over time under different P management strategies. The soil P status is presented relative to a critical P level as determined by a soil test. In the figure it is assumed that starting P levels are adequate which has been a common occurrence in many paddocks in recent years. The status of P reserves can then fluctuate in response to the P management strategy. Three scenarios are presented in Figure 1 as an example:

- **Fertiliser Strategy 1** - a P fertiliser program that maintains soil P levels at a point well above the soil test critical value by taking into account P removal and fertiliser efficiencies for a particular soil. The management risk is associated with using more P than is required to optimise yield.
- **Fertiliser Strategy 2** - a P fertiliser program that is resulting in a rundown in soil P fertility. This can occur when the tie up and fertiliser contribution to the plant is underestimated and the soil P fertility will eventually fall below the soil test critical value. As for the use of no P, the management risk is knowing when the soil test value falls below the critical value and yield is being lost due to inadequate P.
- **No fertiliser** application for a period of time which will run down P reserves, to below critical levels if continued for a sufficiently long period – then production losses will start to occur. The pattern of run down will be determined by the amount of P removed by crops and the ability of the particular soil to supply P to crops. The management risk is knowing when the soil test value falls below the critical value and yield is being lost due to inadequate P.

What happened?

The replacement P trials at Minnipa Agricultural Centre on two soil types are comparing district practice fertiliser rates with replacement P rates (replacing the amount of P removed in the previous grain harvest). Both sites had starting soil P levels well above the adequate range and in the first year there was no response to P, however this was following three years of drought where the fertiliser inputs over the whole paddock would have exceeded crop requirements, resulting in a build up of residual phosphorus. In the above average rainfall seasons of 2010 and 2011, there was a response to added P but due to high yields the replacement P rate was similar to or higher than the district practice of 10 kg P/ha at 8-13 kg P/ha.

As there was no yield advantage from a replacement P rate compared to the district practice rate, the district practice rate of 10 kg P/ha was more economic.

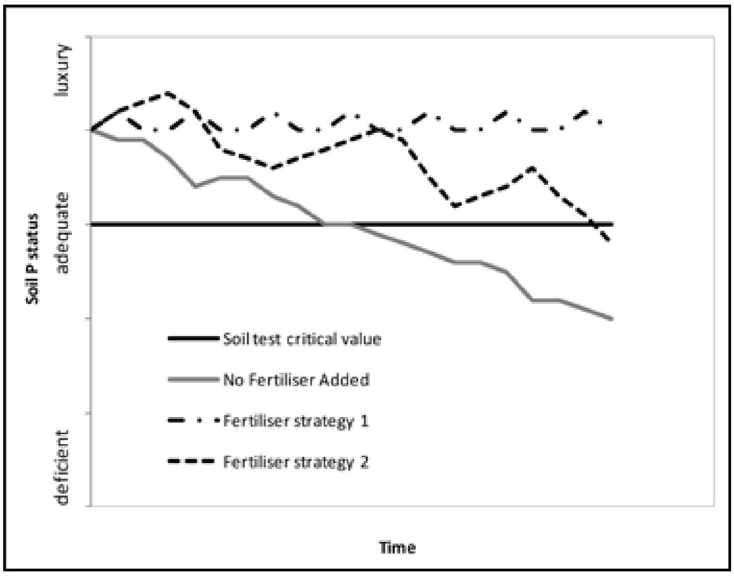

Figure 1. A theoretical outline of the behaviour of soil test P over time in response to different P management strategies. The black bold line shows the soil test critical value. When the soil test is above this line the soil P aat least 90% of maximum yield and when below extra P addition is required in order to achieve maximum yield. The grey line shows the decline in soil test P over time when no fertiliser is added. The black broken lines represent the change in soil test values in response to different fertiliser addition strategies. Strategy 1 maintains the soil test value well above adequate while strategy 2 is a system that is slowly running it down.

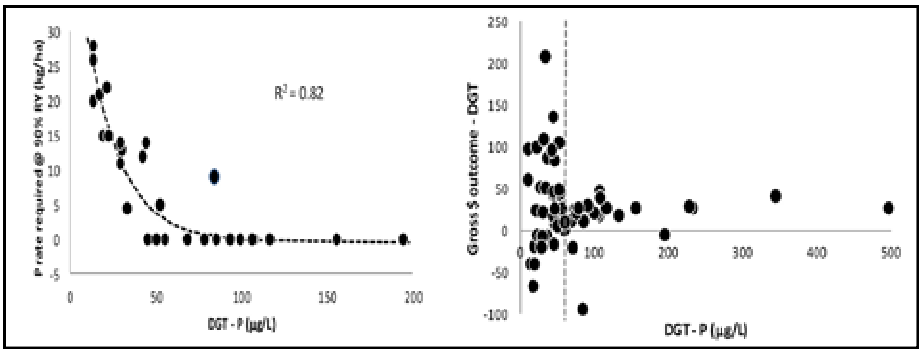

Figure 2a. (left) Relationship of DGT P soil test measurements with the P rate required to maximise yields. Data is obtained from replicated field trials performed during 2006-2010 across Southern Australia and 2b. (right) potential returns using the DGT-P soil test under both deficient and sufficient conditions (dashed vertical line represents the critical value). Data used is from a replicated P response field trial database generated 2006-2010. Parameters used – Wheat @ $200/t, DAP/MAP @ $750/t, Colwell P/PBI @ $15/test, DGT @ $22/test.

While it was possible to achieve equivalent yields for the first year following drought with no P inputs, the high yields of 2009 and 2010 resulted in a decline in soil P fertility and a response to added P fertiliser in 2011. Adjusting fertiliser inputs in response to changes in soil fertility would be of benefit to productivity and profitability.

The residual P site is not yet showing any yield increases with added P suggesting that some sites have sufficient P reserves to grow several crops before inputs are required. The soil P levels are now near soil test critical values for response to P addition so the season of 2012 may provide the answer as to the amount of grain removal that is possible before further P addition is necessary.

What does this mean?

In all trials measuring the sustainability of reducing P inputs, the monitoring of soil fertility is providing clues as to the rundown or maintenance of soil P fertility relative to the critical value. A well calibrated soil test can be used to develop a relationship between soil test value and P addition required to achieve maximum yield (see Figure 2a. as an example with DGT P). When this relationship works well, there is a significant pay-off from investment in soil testing, because soil testing provides reliable information to guide the selection of P rates which will keep soil P reserves at or above the critical value as described in Figure 1. A well calibrated soil test can provide significant economic savings as illustrated in Figure 2b. In this example, returns were calculated using the following:

- If a soil test correctly predicted a site is deficient in P – the positive $ return is the yield gained with P addition minus the cost of the P input; and
- If a soil test correctly predicted the site is sufficient in P – the positive $ return is the savings in not applying P above a starter rate of 5 kg P/ha.

The return made on the extra yield obtained with P application in a deficient soil is of greater $/ha benefit than the cost savings of not applying P in a sufficient soil. The counter balance is that getting the P rate right when managing a responsive situation requires investment up front whereas for a sufficient situation, the $$ can stay in the bank. Getting these costs, benefits and risks in the right balance for you, or your client, is the key. Soil testing can get you closer to that balance.

At the time of writing the commercialisation of DGT is imminent and every attempt is being made in consultation with two soil laboratories to offer a trial service for the 2012 growing season.

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