Can we predict the rundown and long term value of P?

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Key messages

- Using the residual P trial data from Minnipa we have developed a spreadsheet model to predict the rundown of soil P reserves under continuous cropping.
- With this prediction we can attempt to determine the long term value of investment in P fertiliser.
- As expected P applied becomes less valuable with time and is eventually unable to maintain crop productivity at optimal levels if there are no further applications of P. The uncertainty of the outcome also increases with increasing time since soil fertility was monitored.
- This is a work in progress!

Why do the trial?

- Phosphorus (P) fertiliser is the second largest nutrient input on Australian farms and prices are projected to increase as resources become more difficult to extract. Phosphorus is available to the crops as residual P (which includes native soil P and fertiliser P previously applied), and as P fertiliser freshly applied in the growing season. To maximise the economic benefit of soil P it is necessary to be able to predict the ability of soil and fertiliser to adequately supply crop demand for P over time.

- Fertiliser price spikes and a series of droughts both tend to result in farmers reducing inputs of P fertiliser. This decision is an uncertain one as the value of previously applied fertiliser is difficult to predict.

- We also observe the situation of soil P reserves increasing with time when P inputs exceed removal in grain or hay and soil fixation. While this may not be the most efficient use of P it is a risk averse approach that maintains a high soil P supply which allows more flexibility to lower P fertiliser rates in seasons where finance is constrained.

- We wanted to know if we could manage the risk of over or undersupply of P to crops by developing a tool that would predict the change in P reserves with time.

How was it done?

- Data from the residual P trial at Minnipa was used to predict the soil test P response to P exported in grain crops (amount of soil P rundown with different grain yields).
- Laboratory trials were used to predict the amount of fertiliser P that is available to growing plants and not 'fixed' by soil when it is first added.
- A published value was used to predict the ageing of fertiliser in soil which reduces it's availability with time.
- A 60 yr APSIM simulation was used to generate the non-P limited yield potential over a range of season types.
- The calibration curves for the DGT-P soil test was used to estimate the yield penalty caused to the yield potential at different levels of soil test P.
- A bio-economic model (@risk) was used to run 8 yr sequences of yield potential in 50000 different combinations to test the range of possible soil test P rundown possibilities.
- This distribution of possibilities was used to calculate the economic value of soil P with time.

What happened?

With a starting soil test P of 75 µg/L (as was the case for the Residual P trial), the spreadsheet model predicted that there would be a mean yield penalty of 44% due to soil P rundown after 6 years of

cropping with no P addition (Figure 1).

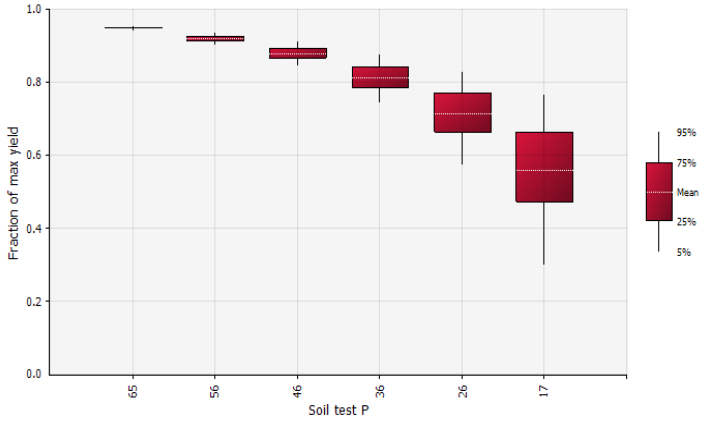

Figure 1. Fraction of potential wheat yield predicted 1-6 yrs after growing crops with no P fertiliser and a starting P level of 75 µg/L DGT-P. Each interval on the x-axis is one cropping year annotated by the resulting soil test level.

We also estimated the effect of repeated cropping with no P input in a system that initially has sufficient P (Figure 2). As expected, allowing the system to rundown results in a reduction in the predicted gross margin with time and these changes start in the third year of cropping. This result suggests that the model may be useful as a predictor of timing of P fertiliser requirement.

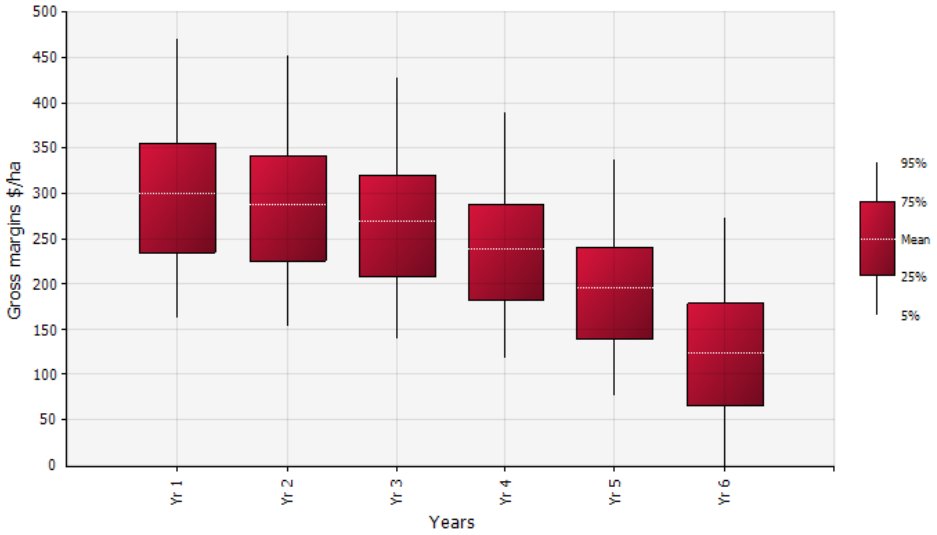

Figure 2. The gross margin ($/ha) predicted 1-6 yrs after growing crops with no P fertiliser and a starting P level of 75 µg/L DGT-P.

Our next step is to make some comparisons using scenarios that are relevant to common farm management practice. For example, what is the yield and economic outcome of repeated inputs of low levels of P (considered low risk management) vs. allowing the system to rundown and adding intermittent large inputs of P in different soils, levels of starting P fertility and climates (crop yield potentials).

Acknowledgements

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Category:

"Searching for answers" – we know what the problem/issue is and we're trying to find out what we can do about it.