Factors affecting critical phosphorus values and responsiveness in different soil types

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Key findings

- The Making Better Fertiliser Decisions for Cropping Systems in Australia (BFDC) database allows us to search for soil test calibrations for four macronutrients across a range of crops, soils types, regions and time spans.
- As an example, the critical range for soil test P (Colwell) for wheat grown in red chromosols in NSW has increased under minimum-tillage management.

Introduction

The Making Better Fertiliser Decisions for Cropping Systems in Australia project (BFDC) aims to provide the fertiliser industry, agency staff, agribusiness advisors and growers with the knowledge and resources to improve nutrient recommendations for optimising crop production. The BFDC database is a national database of historical fertiliser response data for the main grain crops grown in Australia. BFDC is recognised by Fertilizer Australia, the peak body for the industry, as the best available data for supporting the decision tools that fertiliser industry members use as the basis for interpreting soil tests and formulating recommendations.

Fertiliser decisions made by grain growers and their advisers should all start with, and rely on, objective knowledge about their paddock fertility status. These decisions need to account for the plant nutrient requirements for growth, nutrient availability in soils, and nutrient losses that can occur during crop growth (e.g. de-nitrification or erosion).

Making better decisions about soil nutrient management and crop nutrition starts with gaining an understanding of how soil fertility fits into the whole crop production process. The BFDC Interrogator provides information about soil test critical levels for the four nutrients that frequently account for 20–30% of variable crop production costs: nitrogen (N), phosphorus (P), potassium (K) and sulfur (S).

Different soils have different critical nutrient ranges and differing P availability. Understanding your soil type and its critical P values is crucial to making informed fertiliser decisions in cropping. BFDC allows you to look at different soil types, cropping scenarios and many other agronomic factors that may come into play in a season.

Methodology

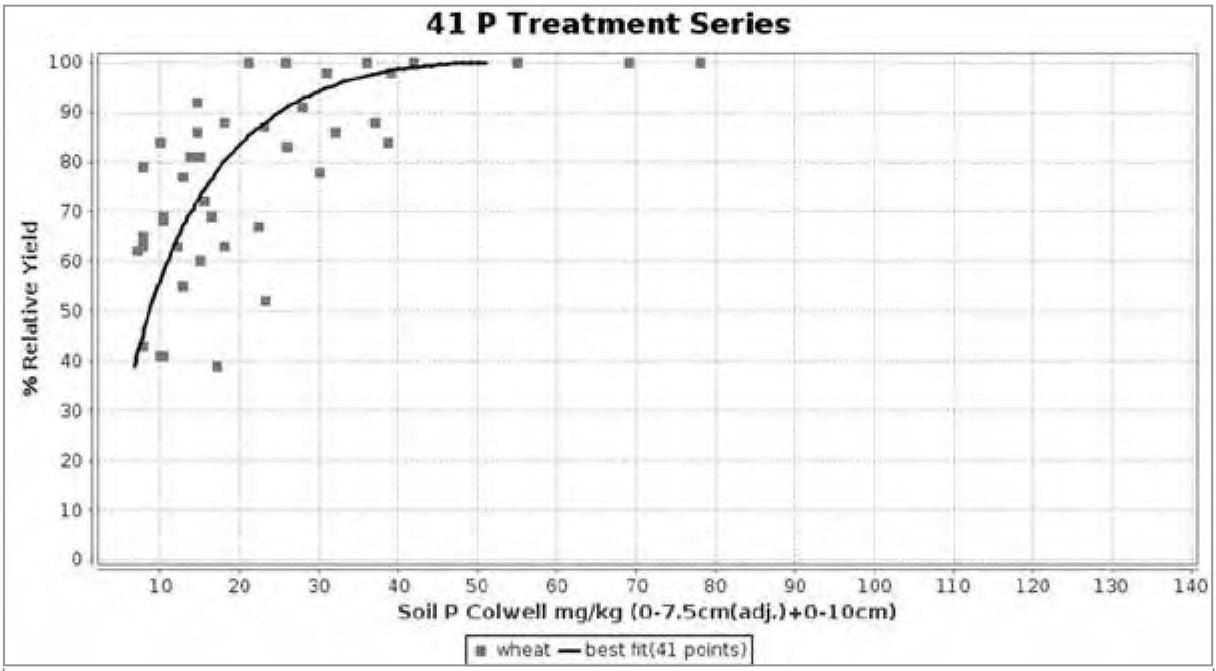
Fifty years of soil test crop response experiments were manually entered into the BFDC database. This historic data was then used, together with current research data sets, to produce soil test calibrations for N, P, K and S. The data is presented in critical nutrient levels for 80%, 90% and 95% of relative yield as well as a confidence range for the relative yield levels. The critical nutrient ranges are across all soil types and can be interrogated for many agronomic fields such as rainfall, soil pH and yield. The major crops are included in the database and the soils are classified under the Australian Soil Classification system. The data sets are classified into A and B data sets depending on how much information is supplied and the experiment's scientific vigour. When filters are applied to the database it can be interrogated to evaluate factors that can affect P responsiveness.

The BFDC database holds extensive historic data for 5698 key N, P, K and S experiment treatment series for different grain crops and soil types across Australia. Each experiment has a soil test and relative grain yield data that enables users to determine the critical soil test values for a range of management and growing conditions. These include farming system, growing season rainfall and paddock history.

The data set is currently still being added to by researchers from the More Profit from Crop Nutrition (MPCNII) program, as well as agency researchers and agribusiness via the online data entry tool.

Results and discussion

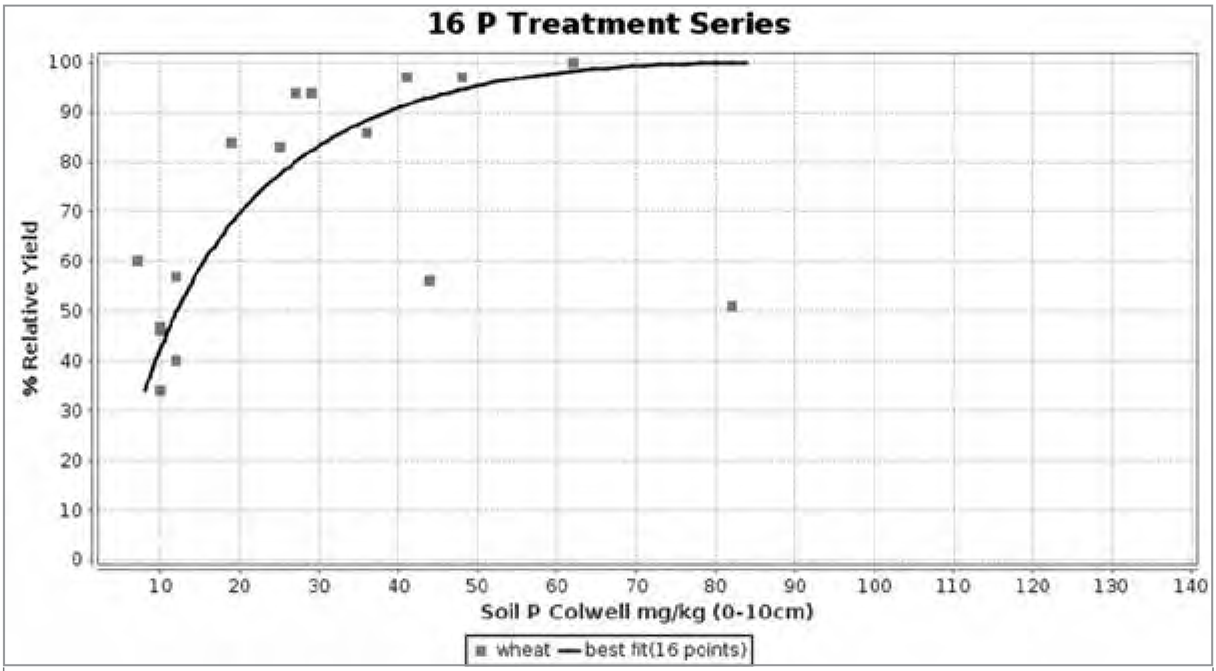
The database allows the authorised user to interrogate the database across different soil tests, tillage systems and growing seasons, which enables the user to calibrate a soil test crop response for their own particular conditions. For example, a consultant wishing to know the critical P range for wheat on a red chromosol can interrogate the database and find the levels required for 80%, 90% and 95% relative yield pre-1987 when full cultivation was common (Figure 1), or from 1990 when minimum tillage became more common (Figure 2).



Soil test calibration:

80% Relative yield: 18.0 (15.0–22.0)	Correlation R: 0.73	Slope RY(50–80): 3.2 (2.2–4.2)
90% Relative yield: 25.0 (20.0–31.0)	Regression equation: $x = e^{(2.2924(\arcsin(\mathrm{sqrt}(y/100))) + 0.35343)}$	
95% Relative yield: 31.0 (24.0–40.0)	70% confidence limit at 90% Relative Yield: 25.0 (22.0–28.0)	

Figure 1. Calibration of relative yield of wheat with Colwell P on red chromosols pre-1987.



Soil test calibration:

80% Relative yield: 27.0 (15.0–47.0)	Correlation R: 0.61	Slope RY(50–80): 2.0 (0.54–3.5)
90% Relative yield: 38.0 (20.0–75.0)	Regression equation: $x = e^{(2.5023(\arcsin(\mathrm{sqrt}(y/100))) + 0.52267)}$	
95% Relative yield: 49.0 (22.0–110.0)	70% confidence limit at 90% Relative yield: 38.0 (27.0–54.0)	

Figure 2. Calibration of relative yield of wheat with Colwell P on red chromosols post-1990.

The data shows that the apparent critical P range was lower under conventional tillage practice. This could be attributed to the nutrient stratification that can occur in minimum or no till situations. The P might be concentrated in the top few centimetres and not throughout the surface 10 cm where the crop can more readily access it.

Col McMaster, Research Agronomist at Cowra is continuing this work by evaluating response to different rates of P under contrasting cultivation regimes. Other team members are evaluating N × P interactions at high rates on N and the corresponding rates of P required to meet crop demand (projects UA00154, DAN00168).

Acknowledgements

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See more at grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/BFDC-Interrogator#sthash.8XA7MxF6.dpuf