

Predicting P Response in Rainfed Winter Cereals on Diverse Soils using Soil Analysis

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INTRODUCTION

Phosphorus (P) fertilizers are commonly applied to agricultural soils for winter cereal production, and they represent a significant proportion of the variable costs of crop production. Many areas now have high plant-available soil P levels and regular application of P fertilizers is no longer required to achieve profitable yields (Sims and Vadas 2005). However, in all cases, soil testing can provide key information for improved decision making about P management.

Recently in Australia, a national database (the *Better Fertilizer Decisions for Crops (BFDC) National Database*) of nutrient response trials for grain crops has been assembled (Watmuff *et al.* 2013). The treatment series entered were subject to rigorous checks to ensure they were valid for re-analysis in the database. The database represents a valuable resource with which to assess response of winter cereals to P across a wide range of cropping eras (modern vs earlier periods), soil types, seasonal conditions, sampling depths, soil test methods and species. The objective of this study was to examine factors affecting critical soil P test concentrations and confidence intervals for wheat and barley grown in Australian soils by interrogating validated data held in the *BFDC National Database*. Most emphasis was placed on the Colwell extractant for soil P (Colwell 1963) since it was the most widely used test and the one for which the largest and most comprehensive dataset existed.

METHODS

Full details of the study are reported in Bell *et al.* (2013). This study examined factors affecting critical soil P concentrations and confidence intervals for wheat and barley grown in Australian soils by interrogating validated data from 1777 wheat and 150 barley field treatment series now held in the *BFDC National Database*. Calibration curves of relative yield response to applied P *versus* soil test value were constructed by the *BFDC Interrogator* using the algorithm described by Dyson and Conyers (2013). From the fitted regression, critical values corresponding to 90 and 95 % of maximum relative yield plus associated 70 or 95 % confidence intervals for these values were reported by *BFDC Interrogator*. In addition, the calculated correlation coefficient (*r*) for each relationship indicated the goodness of fit of the regression to the data. In the present study, we aimed to achieve *r* values of > 0.6. Confidence intervals for the critical concentrations were minimized by filtering out treatment series with low yield, severe crop stress and low pH.

RESULTS AND DISCUSSION

There was a clear increase in critical P concentration from early trials to those conducted from 1995-2011 which corresponds with a rapid shift towards adoption of minimum tillage (Table 1). Once treatment series with low yield (< 1 t/ha), severe crop stress and pH CaCl₂ < 4.3 were screened out, critical concentrations were relatively insensitive to wheat yield (> 1, > 2 or > 3 t/ha). For wheat, critical Colwell P concentrations varied among soil types based on Australia Soil Classification (Isbell 2002) Orders and Sub-orders. Critical Colwell P concentrations at 90 % of maximum relative yield from 15 (Grey Vertosol) to 46 mg/kg (Supracalcic Calcarosols), with other soils having values in the range 19 to 28 mg/kg. Only when the measured P buffering index (PBI) reached levels classed as moderate or higher did the critical P concentration increase significantly. In general there was no evidence that critical concentrations for barley were different to those for wheat on the same soils.

Table 1. Critical concentrations (CC), confidence interval (CI) and regression coefficients for Colwell P soil test (0-10 cm depth) partitioned by samples taken from 1958-1980, 1981-1994 and 1995 - 2011 for all soils across Australia.

Era	Number of treatment		CC	CI	r
	series				
1958-1980	665		20	19-22	0.57
1981-1994	246		20	18-22	0.68
1995-2011	231		26	22-31	0.35

CONCLUSIONS

Significant knowledge gaps which could improve the relevance and reliability of soil P testing were: the paucity of treatment series reflecting current cropping practices, especially minimum tillage, and; inadequate metadata on soil texture, pH, growing season rainfall, gravel content and PBI. The critical ranges determined in the present study illustrate the importance of recent experiments and of soil type, but also provide examples of interrogations pathways into the *BFDC National Database* using the *BFDC Interrogator* to extract locally relevant critical P concentrations for guiding P fertilizer decision-making in wheat and barley.

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