Availability of phosphate fertilizer residues in a soil of western Queensland during three years of cropping

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Many soils of Western Queensland are potentially responsive to phosphate fertilizer (1). Experiments in 1975 to 1977 showed that eighty percent of crops grown on soils with a bicarbonate test lower than 15 pg g^{-1} responded economically to freshly-applied fertilizer

A further study at Tara had two objectives; (i) to quantify the value of phosphate to successive crops in terms of plant response and soil test, and (ii) to assess the influence of fertilizer residues on the bicarbonate-extractable phosphate test value.

Methods

In April 1978, phosphate fertilizer was applied at 0, 25, 50, 100, 200 or 400 kg P/ha and mixed into the topsoil with successive cultivations before planting wheat. Additional plots received 4, 8, 12, 25, 50 or 100 kg P/ha annually.

Plots were sampled annually to a depth of 10cm before planting wheat for bicarbonate-extractable phosphate determination. At the same time sufficient soil was removed from experimental plots to conduct a pot experiment to compare the availability of fertilizer residues with that of freshly added-fertilizer. In addition, pots used in the first year's experiment (1979) have been continuously and exhaustively cropped with successive wheat and sorghum crops in 1980 to measure the proportion of the original P application that could be recovered.

Results and Discussion

Bicarbonate soil test was a satisfactory guide to the relative grain yield response to fertilizer residues in the field, $RY = 100 - 81\ (0.26)^{P/10}$, $R^2 = 0.64$; and in the glasshouse, $RY = 100 - 95\ (0.63)^{P/10}$, $R^2 = 0.91$, where RY = yield/maximum yield and P = bicarbonate soil test. Response under field conditions would indicate that the suggested critical soil test value of 15 pg g^{-1} is satisfactory for soils of this region. Results also support the use of the soil test for previously-fertilized soils.

Given the generally low rates of phosphorus removal by wheat crops in this region, the value of phosphate residues (RVF) appears to follow the decay curve, $RVF = 0.8/(0.8 + t)$, where t = years after application. The value of residues in soil exhaustively cropped in pots declined much faster.

The effect of soil water relations on the uptake of fertilizer residues is evident by contrasting results of field and glasshouse experiments. Under favourable moist conditions in the field in 1978, the apparent recovery of freshly-applied phosphorus was considerable (7-15 kg ha^{-1}). However, removal of residues declined dramatically (0-3 kg ha^{-1}) during the following two dry seasons. In contrast, well-watered plants in the glasshouse displayed high recoveries of residues by successive wheat (5-49 kg ha^{-1}), sorghum (2-46 kg ha^{-1}), and wheat (0.5-30 kg ha^{-1}) crops. Because of the apparent dependence upon good soil water relations, response to phosphate residues may not be evident in many Queensland crops which are generally grown on limited growing-season rainfall.

1. Best, E. K., Strong, W. M. and Counter, J. M. (1978). Queensland Wheat Research Institute biennial report 1976-1978; 45-47.