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Reply to 'Comments on papers relating to soil phosphorus testing in 'Making better fertiliser decisions for cropping systems in Australia'' by I.C.R. Holford

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In his 'Comments on papers relating to soil phosphorus testing', Dr Ian Holford raises several points requiring responses, and we trust that the following statement addresses the salient points raised by Dr Holford with respect to the specific papers. We have attempted to clarify and elaborate on issues not already explained in detail in the original papers.

Paper 3: Dyson and Conyers (2013)

As stated on p. 426 of Watmuff *et al*. (2013), three response curves are fitted to the yield data of individual P rate experiments for the purpose of calculating Y0 and Ymax. The onus is on the person entering the trial data to decide which curve best fits the data for that site; the *BFDC Interrogator* does not prescribe which equation should be applied. Once the user selects the best fit equation, Y0 and Ymax calculated by that equation are used to derive the single relative yield datapoint that each experiment contributes to a calibration curve.

The equation used to describe the calibration curve does not pre-suppose any underlying biological model – in brief (pp. 437–439), the methodology linearises the relative yield versus soil test data by transformations, constraining maximum relative yield to unity. Back-transformation of the resultant linear equation of best fit allows confidence intervals at $P = 0.05$ and $P = 0.30$ to be derived for 'critical' soil test values at 0.9 relative yield (or 0.95 relative yield if preferred). As stated on p. 477 in Speirs *et al*. (2013), a comparison of the relative width of these confidence intervals is considered to be a better estimate of the diagnostic usefulness of a soil test for indicating responsiveness than by simply comparing the R^2 of any equations of best fit applied to the calibration data, as is suggested by Holford.

As indicated by Holford, there are two questions that need to be answered by prognostic soil tests: Is the nutrient limiting yield, and if so, how much nutrient needs to be applied to address this limitation? As stated in pp. 436–437 of Dyson and Conyers (2013), there were many limitations in terms of number of treatments, statistical design, replication, etc. for the individual experiment datasets that precluded estimation of the yield curvature coefficient to applied P. Even if it had been possible to obtain curvature coefficients from a sufficient number of sites, establishing a relationship between curvature and soil P buffer capacity (the most likely determinant of this curvature) was not possible because of the absence of P buffer capacity measurements for many soils. Moody (2007) encountered this same problem when developing relationships between critical Colwell-P values and P buffer capacity for data from a much smaller number of published studies. Irrespective of these data constraints, the decision on how much fertiliser to apply is as much an economic decision as one based on soil tests, and is best derived by the grower and adviser.

Paper 5: Moody et al. *(2013)*

Holford incorrectly contends that Colwell, BSES, Olsen and Mehlich 3 are assigned to P quantity estimates in this paper. While we have suggested that BSES-P and Colwell-P can be loosely assigned to mineral P and sorbed P (Table 5, p. 465), we have avoided consigning any special status to the P extracted by the Olsen and Mehlich 3 methods because they are composite P quantity-intensity indicators (none of these empirical soil P tests are absolute measures of available P). We disagree with Holford that 'available P' is an absolute quantity (it varies with time, species, etc.) (Williams 1962), so we have not distinguished between 'availability' and 'available'.

Holford questions the justification for the choice of soil P tests used in this paper; they were selected either because they could be assigned to a soil P pool (Colwell-P, BSES-P, $CaCl_2$-P, FeO-P, DGT-P), or are widely used overseas (Olsen-P, Mehlich 3-P). The same criteria were applied to the choice of soil P tests used in Paper 6 by Speirs *et al*. (2013) (see Introduction, pp. 469–470) and while the results of the lactate soil P test calibrations in NSW are referred to, there were no lactate-P data available for other regions of southern Australia for use in the broad regional wheat calibration studied in this paper. A great strength of the *BFDC Interrogator* is that it can be used either at broad scale [as in the southern Australia wheat example in Speirs *et al*. (2013)] or at a more localised scale, as could be done in the regions where lactate-P data are available in the database.

Paper 7: Bell et al. *(2013)*

Holford questions the practicality of identifying a sample's Soil Order, but as stated in Bell *et al*. (2013) on p. 492, there were insufficient PBI data to examine the effect of soil P buffer capacity on critical soil P test values. There were, however, more records of soil type, so Soil Order was used as a surrogate for this soil characteristic.

Holford correctly points out a few inconsistencies in reported experimental details and references cited in this paper, and we present an erratum as an attachment for the Editor's consideration. Notwithstanding the corrections below, the conclusions of Paper 7, as published, remain valid.

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