Data Mining of Past Fertiliser Response Experiments to Construct Soil Test Calibrations

Richard Bell¹, Mark Conyers², Simon Speirs², Mike Bell³, Nigel Wilhelm⁴, Graeme Watmuff⁵, Chris Dyson⁴, Brendan Scott², Rob Norton⁶, Charlie Walker⁷, Douglas Reuter⁸ and Ken Peverill⁹

¹School of Veterinary and Life Sciences, Murdoch University, 90 South Street, Murdoch WA 6150 Australia
(R.Bell@murdoch.edu.au)
²NSW Department of Primary Industries, Wagga Wagga, New South Wales NSW 2650 Australia
³Queensland Alliance for Agriculture & Food Innovation, POBox 23 Kingaroy, Qld 4610 Australia
⁴South Australian Research & Development Institute, GPO Box 397, Adelaide, SA 5001 Australia
⁵Geographic Web Solutions Pty Ltd 17 Tay Road, Woodforde SA 5072 Australia
⁶International Plant Nutrition Institute, Horsham, Vic 3400 Australia
⁷Incitec Pivot Fertilisers, PO Box 54, North Geelong, Vic 3215 Australia
⁸Reuter and Associates, Medindie, South Australia SA 5081 Australia
⁹K I P Consultancy Services Pty Ltd, 4 Collier Court, Wheelers Hill, Vic. 3150 Australia.

INTRODUCTION

Soil testing remains the most valuable tool for assessing fertiliser requirements of crops. While for individual studies and for specific regions experimental data have been used to construct critical soil test values, rarely has a complete data base been assembled to objectively and systematically determine the most appropriate critical concentrations. Many countries now have an extensive legacy of completed fertiliser response experiments for which there is accompanying soil test information. In Europe, the variability in soil test methods made it difficult to assemble a consolidated database with which to assess critical soil P test levels (Jordan-Meille et al. 2012). In Australia, the BFDC National Database was compiled for crop grain yield response to N, P, K and S (bfdc.com.au). The present paper summarises the key learning from this project and lessons it contains for future investment in crop nutrition research.

METHODS

The BFDC National database contains 5176 treatment series (a treatment series comprises the mean yields at the various rates applied of the single nutrient in a single experiment) assembled after rigorous checking to ensure the experiments complied with minimum standards. The design of the BFDC National Database is described by Watmuff et al. (2013). Critical concentrations and confidence intervals were determined from trial datasets defined by crop species, nutrient, soil test method, and sampling depth. Filters were applied to the data to remove effects of crop yield, soil pH, and crop stress on the relationship. A BFDC Interrogator specialised regression function was fitted to the composed data set to estimate the soil test value that would achieve 90% or, alternatively, 95%, of potential yield.

RESULTS AND DISCUSSION

Notwithstanding > 5,000 treatment series in the BFDC National Database, the records were dominated by N and P data and for wheat experiments (Table 1). Hence, for oilseeds, barley, and pulses there were often inadequate data to fit relationships. Moreover, regional distribution of the experiment locations often meant that a large proportion of the data, for example P and K for lupin or S for canola, were from limited geographical spread. Since the wheat treatment series were most prevalent, critical ranges developed for other species were benchmarked against those for wheat (Bell et al. 2013a). Given the nature of the data assembled, from multiple studies over many sites, regions and years, it was concluded that critical ranges (based on 70 and 95 % confidence
intervals) were a more realistic way to summarise the soil test criteria than critical concentrations. While assembling treatment series for the BFDC National Database, it was necessary to reject a large proportion of potential experiments due to inadequacies in the way the experiment was conducted or reported. These primarily centered on poorly defined maximum yield for the trial. A key learning was the need for a standardised protocol for the conduct of plant nutrition trials. The BFDC National Database also has the provision to record metadata for each experiment, including site rainfall, soil classification, soil pH, texture, and crop stress. The metadata for pH and crop stress were valuable for improving relationships between crop yield response and soil test value, particularly for soil P (Bell et al. 2013b). However, a low proportion of treatment series reported a full range of metadata and this limited the extent to which factors affecting critical ranges could be determined.

Table 1. Summary of treatment series in BFDC National Database according to crop type and nutrient. Source: Conyers et al. (2013).

<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>Barley and other winter cereals</th>
<th>Summer cereals</th>
<th>Canola and oilseed rape</th>
<th>Other oilseeds</th>
<th>Narrow leaf lupin</th>
<th>Pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1377</td>
<td>137</td>
<td>93</td>
<td>212</td>
<td>24</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>P</td>
<td>1706</td>
<td>153</td>
<td>50</td>
<td>78</td>
<td>12</td>
<td>465</td>
<td>153</td>
</tr>
<tr>
<td>K</td>
<td>281</td>
<td>4</td>
<td>8</td>
<td>138</td>
<td>10</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>S</td>
<td>116</td>
<td>1</td>
<td>5</td>
<td>157</td>
<td>-</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

CONCLUSIONS

This approach would be worth examining for those countries that now have a large legacy of fertiliser response experiments but have not used IT tools to assemble their data for interrogation. Moreover, in those countries that are in the process of conducting crop nutrient rate experiments, the development of a database could greatly add value to the outcome by increasing the number of compliant experiments. In both cases a major gain from the data mining exercise is likely to be identification of gaps to target the selection of soils, crops, nutrients and regions for further experiments, and to identify appropriate sampling and soil test methods.

ACKNOWLEDGEMENTS

The authors thank the Grains Research and Development Corporation for funding the work and many scientists for generous unpaid work to assist the development of the database.

REFERENCES


