MAKING BETTER FERTILISER DECISIONS FOR CROPPING SYSTEMS IN AUSTRALIA

CASE STUDY: ***Phosphorus in wheat***

Fertilisers can contribute more than 20% of variable costs to broadacre grain production. Despite these costs, there tends to be a low level of confidence in soil testing to underpin fertiliser decisions on farms.

CASE STUDY SITUATION

- An advisor in northern New South Wales is exploring the critical Colwell P soil test concentration for wheat grown on all vertosol soils in Australia (heavy cracking clay soils).

To help increase confidence in soil testing, more than 5000 soil test–crop response results from across Australia have been compiled by the *Making Better Fertiliser Decisions for Cropping Systems in Australia* project (BFDC).

The *BFDC National Database* includes all available trials for nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) use in cereal, oilseed and pulse crops.

The online *BFDC Interrogator* has been built to enable members of the grains and fertiliser industries to develop soil test–crop response calibrations and critical soil test values for different crops.

Registered access to the *BFDC Interrogator* is available after successful completion of a BFDC training workshop.

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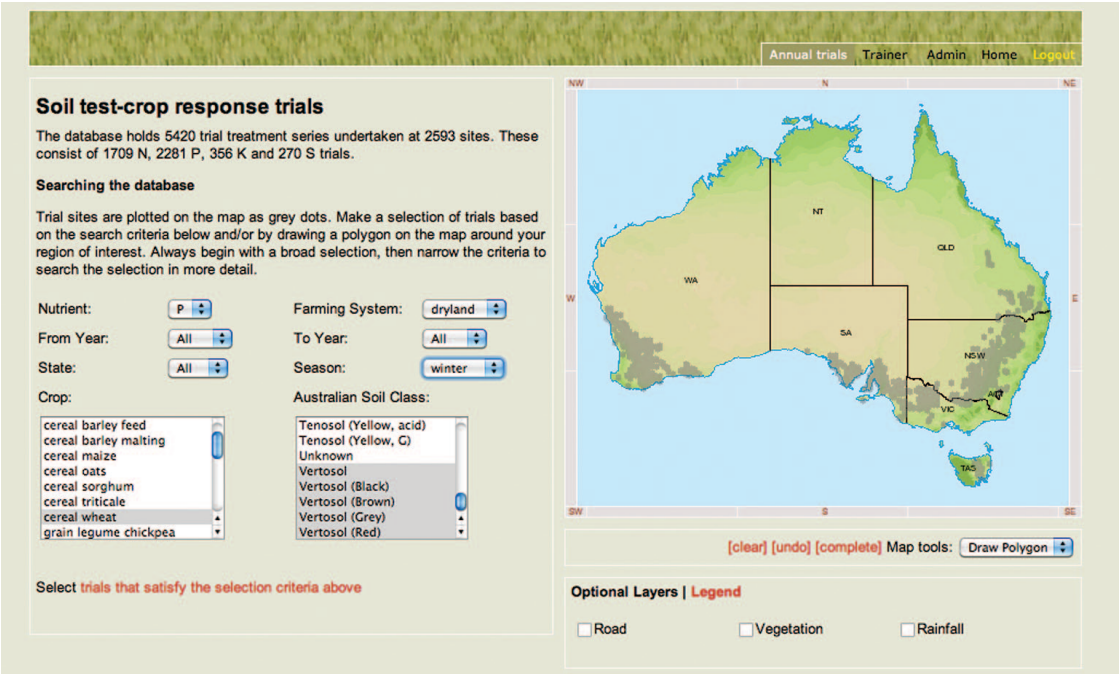
IDENTIFYING SOIL TEST–CROP RESPONSE TRIALS

The *BFDC Interrogator* enables users to select from all of the national trials (locations shown as grey dots on the map in Figure 1).

For this case study, the user first selects '**phosphorus**', '**cereal wheat**' and all five **vertosol soils** to give a large data set. This means that the list of possible trials is not narrowed at the start of interrogation.

On the Soil test–crop response trials page (see Figure 1), the following options were selected: Nutrient — 'P', Farming System — 'dryland', From Year — 'All', To Year — 'All', State — 'All', Season — 'winter', Crop — 'cereal wheat' and Australian Soil Class — all of the 'vertosols'. The user then clicks on the 'Select trials that satisfy the selection criteria above' option.

Figure 1. Soil test–crop response trials



SOIL TEST–CROP RESPONSE CALIBRATIONS

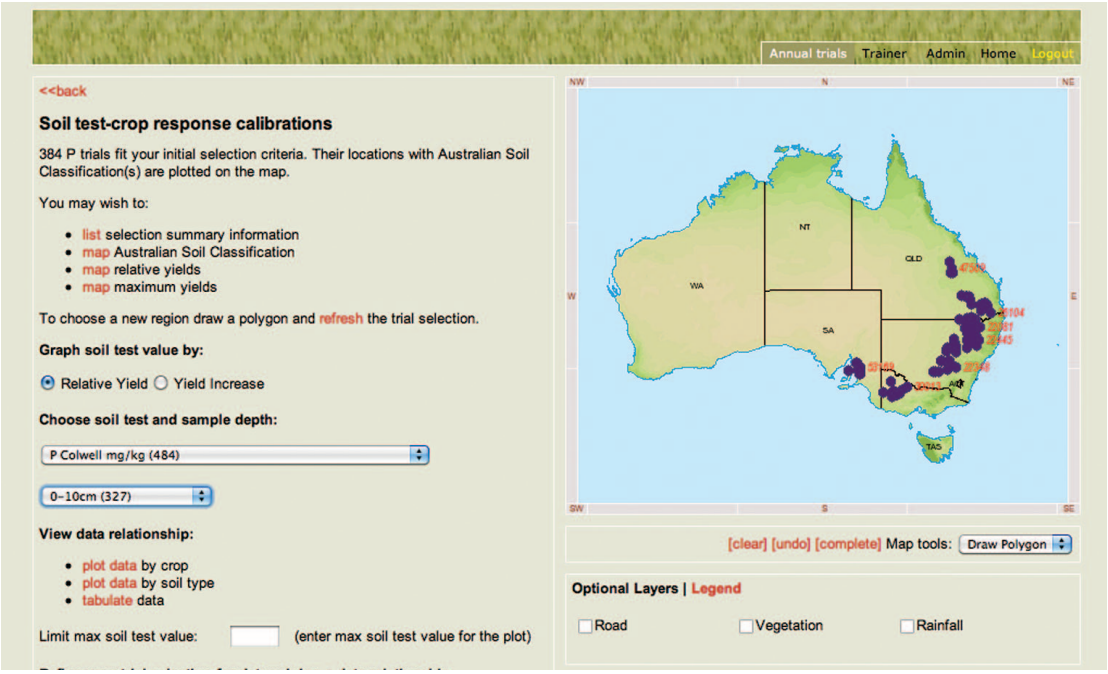
The screen changes to the **Soil test–crop response calibrations** page (see Figure 2), where the selection of trials is refined and soil test–crop response criteria are derived. The map of Australia shows the location of all currently selected trial sites (coloured dots); initially '**384 P trials**' were selected (see Figure 2).

On the Soil test–crop response calibrations page (see Figure 2), the following options were selected: 'Choose soil test and sample depth' — select 'P Colwell (mg/kg)' and '0–10 cm'. 'Relative Yield' was the default selection under 'Graph soil test values by'. The user then clicks on the 'plot data by soil type' option.

There are also numerous filter options, which allow users to further refine a calibration relationship (these are not demonstrated in this case study).

The percentage relative yield **(% RY)** is the yield at no fertiliser **(Y_0)** expressed as a percentage of the maximum yield **(Y_{max})** obtained for a trial with fertiliser application **(Y_0 / Y_{max}) × 100**.

Figure 2. Soil test–crop response calibrations



CALIBRATION RELATIONSHIPS

A graph is plotted for the data selected, with soil test axis (x axis) and the relative yield axis (y axis), with each of the different vertosol soils shown as different colours (see Figure 3).

The *BFDC Interrogator* fits a calibration curve to the trial data selected and calculates the soil test concentrations at the 80, 90 and 95% RY with their 95% confidence limits for the fitted curve.

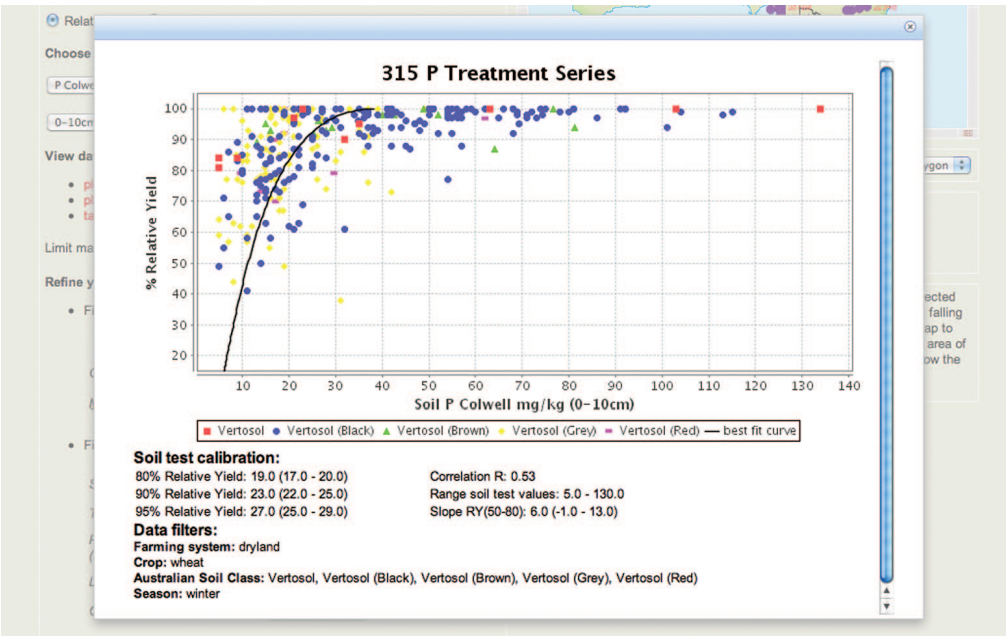
In this case study, the RY calibration plot shows that 315 treatment series met the revised selection criteria.

Note: *Most of the data selected were from black vertosol soils. A calibration curve for black vertosol soils alone could be determined by selecting only '**Vertosols (Black)**' on the* **Soil test–crop response trials** *page (see Figure 1 , page 2).*

A treatment series is a response calibration data point. A trial may have one or more treatment series. For example, some trials may use different phosphorus fertilisers (for example, fluid vs granular), different tillage systems (for example, no-till vs multiple tillage), or different placements of phosphorus at a range of rates. This could give a number of crop responses to phosphorus (treatment series) for a single trial.

The calibration curve shows that a critical soil test concentration of 23 mg/kg Colwell P associated with 90% RY. The critical range of Colwell P value was 22–25 mg/kg (95% confidence limits). The fit to the data was *good* with an 'R' correlation coefficient of 0.53. A minimum 'R' value of 0.15 is required for a data set to be accepted. Scrolling downward shows details of the data and filters selected.

Figure 3. Calibration relationships



TRIAL REPORTS

The selected data shown in the calibration relationship include several outliers. A trial report can be obtained for any trial shown in the database. In this case study, an outlying point was selected.

Place the cursor over the data point, which displays the trial number (in this case 46717; see highlighted trial number in the middle of the graph in Figure 3, page 4), and click on the point.

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Figure 4. Trial report

Trial 46717

Sown:	16 july 1967
Harvested:	november
Site:	1967 trial 17
Location:	Colonsay QLD
Data owner:	QDPI
Data custodian:	Strong
Season:	winter
Farming system:	dryland
Experimental Design:	Nutrient Rate Factorial (eg N rates x P rates)
Crop:	cereal: wheat
Rainfall Period:	november - march
Growing season rainfall (mm):	Farm: 159
Stored Profile Water (mm):	317
Soil Water Holding Capacity:	327
Australian Soil Classification:	Vertosol (Black)
Local Soil Name:	Waco
Nutrient(s) studied:	N,P
Fertiliser Products used:	urea (N) superphosphate double (PS)
Reference:	W M Strong, J K Hitchener and J E Cooper, Unpublished data

Paddock History

For the year immediately preceding the trial:
Rotation : cereal
Fallow System : short 3-7months
Tillage System : multiple tillage pre sowing
Row Spacing : 18cm

Soil Samples

ID : 2282
Depth : 0-10cm
Timing : before sowing 2 months
Position : random
Texture : clay
No Sub Samples : 4
Percent Clay : 86

Soil Test	Value	Units
P BSES	300.0	mg/kg
P Colwell	32.0	mg/kg
pH Soil water 1:5	8.7	
N Total soil	0.095	%
Organic C (Walkley-Black)	1.0	%
N Anaerobic 2wks 30C Waring and Bremner 1964	55.0	mg/kg
N Anaerobically 1 wk 40C	72.0	mg/kg
N Aerobically 2 wks 30C Keeney and Bremner 1967	22.0	mg/kg
C/N ratio	11.0	

ID : 2283
Depth : 0-30cm
Timing : before sowing 2 months
Position : random
Texture : clay
No Sub Samples : 4

Soil Test	Value	Units
N Nitrate N	33.0	kg/ha

ID : 2284
Depth : 0-60cm
Timing : before sowing 2 months
Position : random
Texture : clay
No Sub Samples : 4

Soil Test	Value	Units
N Nitrate N	50.0	kg/ha

ID : 2285
Depth : 0-90cm

Treatment Series Statistics

Treatment Series ID : 1655
Nutrient Studied : N
P rate : 40.00000
Time of Application : sowing
Nutrient Placement : side banded
Tillage System : multiple tillage pre sowing
Row Spacing : 18cm
Product : urea

No Treatment Data

Statistical Analysis:
Response Measured : mean grain yield (t/ha)
Statistical Model : Square root

Coefficients	Statistics
A: 0.52500	Ftest:
B: 0.0519000000	100r2:
C: -0.0028582000	LSD 05:
Yo: 0.525	RY: 69
Ymax: 0.761	CV:

Treatment Series ID : 1656
Nutrient Studied : P
N rate : 67.00000
Time of Application : sowing
Nutrient Placement : drilled with seed
Tillage System : multiple tillage pre sowing
Row Spacing : 18cm
Product : superphosphate double

No Treatment Data

Statistical Analysis:
Response Measured : mean grain yield (t/ha)
Statistical Model : none

Coefficients	Statistics
A:	Ftest:
B:	100r2:
C:	LSD 05:
Yo: 0.451	RY: 61
Ymax: 0.740	CV:

(Continued from page 5)

Trial 46717 was carried out during 1967 at Colonsay in Queensland (see Figure 4, page 5). This was an N×P factorial experiment from which the response to phosphorus at adequate nitrogen is reported.

An assessment of the trial report shows a crop response to phosphorus (% RY 61) at a Colwell P of 32 mg/kg. The report also shows a crop response to nitrogen fertiliser at adequate phosphorus. Yields at the site in that year were low (maximum yield 0.8 t/ha).

Like all trials, this example was closely examined before being entered into the BFDC National Database, and no scientifically valid reason can be found for its exclusion.

The data set could be eliminated in this case study by filtering for maximum yield above 1 t/ha.

Registered users of the *BFDC Interrogator* can only exclude specific trials from a calibration by using the filter options or by limiting the extent of the soil test axis to exclude excessively high (outlier) values of the soil test. More information on the use of filters is given in other case studies: ***Phosphorus in canola and Potassium in wheat***.

CONCLUSION

The critical value of Colwell P concentration in the 0–10 cm depth on vertosol soils was 23 mg/kg with a critical range of 22–25 mg/kg.

The relationship was *good* (R = 0.53), despite several clear outliers.

Acknowledgements

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Disclaimer

This case study is an example of the use of the *BFDC Interrogator* obtained from trial data entered into the database before December 2011. The *BFDC Interrogator* does not provide a fertiliser recommendation and this example does not seek to interpret the calibration relationship. The case study demonstrates the scope of the database and how the data can be used. Contact your FERTCARE® Accredited Advisor if you would like more information.

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