



MAKING BETTER FERTILISER DECISIONS FOR CROPPING SYSTEMS IN AUSTRALIA

CASE STUDY: *Sulphur in canola*

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 agronomist wants to check the estimated critical $KCl_{40}S$ (0-10 cm) for canola with a yield potential >1 t/ha.



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.



Department of
Primary Industries



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 ‘S’, ‘oilseed canola’, ‘dryland’, ‘winter’ and ‘All’ 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 – ‘S’, Farming System – ‘dryland’, From Year – ‘All’, To Year – ‘All’, State – ‘All’, Season – ‘winter’, Crop – ‘oilseed canola’ and Australian Soil Class – ‘All’. 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 trials

The database holds 5420 trial treatment series undertaken at 2593 sites. These consist of 1709 N, 2281 P, 356 K and 270 S trials.

Searching the database

Trial sites are plotted on the map as grey dots. Make a selection of trials based on the search criteria below and/or by drawing a polygon on the map around your region of interest. Always begin with a broad selection, then narrow the criteria to search the selection in more detail.

Nutrient: **S** Farming System: **dryland**

From Year: **All** To Year: **All**

State: **All** Season: **winter**

Crop: **oilseed canola**

Australian Soil Class: **All**

Select trials that satisfy the selection criteria above

Map tools: **Draw Polygon**

Optional Layers | Legend

☐ Road ☐ Vegetation ☐ Rainfall



SOIL TEST-CROP RESPONSE CALIBRATIONS

The screen changes to the **Soil test-crop response calibrations** page (see Figure 2, page 4), where the selection of trials is refined and soil test-crop response criteria are derived. The map of Australia now shows the location of all 152 initially selected trials (shown as coloured dots).

Note: The points highlighted on the map in Figure 2 are soils where sulphur soil test data exist for experiments on canola and cover a full range of grain yields. Users can then select a filter to identify trials with specific grain yields.

On the **Soil test-crop response calibrations** page (see Figure 2, page 4), the following options were selected: 'Choose soil test and sample depth' — select 'S KCl40 extractable mg/kg' and '0-10 cm'. 'Relative Yield' was the default selection under 'Graph soil test values by'.

Scroll down and select 'Maximum yield above 1 t/ha'. This filter will eliminate lower-yielding trials from the selected data set. Click on 'View data relationship' to obtain a calibration. Initially select the 'Tabulate data' option.

In this case study the 'grain yield' filter option has been used.

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 $(Y_0 / Y_{max}) \times 100$.

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Figure 2. Soil test-crop response calibrations

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Soil test-crop response calibrations

152 S trials fit your initial selection criteria. Their locations with Australian Soil Classification(s) are plotted on the map.

You may wish to:

- list selection summary information
- map Australian Soil Classification
- map relative yields
- map maximum yields

To choose a new region draw a polygon and **refresh** the trial selection.

Graph soil test value by:

☒ Relative Yield ☐ Yield Increase

Choose soil test and sample depth:

S KCl40 extractable mg/kg (446)

0-10cm (131)

View data relationship:

- plot data by crop
- plot data by soil type
- tabulate data

Limit max soil test value: (enter max soil test value for the plot)

Refine your trial selection for determining a data relationship:

- Filter by rainfall, maximum yield, soil pH and/or soil organic carbon:

Above

Below

Growing season rainfall:

Maximum yield:

Soil pHCaCl2:

Soil organic carbon:

mm

mm

t/ha

t/ha

%

%
- Filter by any of the trial characteristics below:

Soil texture:

Last land use:

Any

Any

Subsoil nutrient effect:

This filter is useful only for K and S trials where soil test data have been collected from multiple depths (e.g. 0-10cm, 10-20cm). Choose a surface soil sample depth and enter a suitable soil test (e.g. Colwell K) above. Below, choose a subsoil sample depth and a value for this soil test (e.g. 25 mg/kg) which represents an adequate nutrient level. Click the 'plot calibration' link below to show which surface samples have corresponding adequate or inadequate subsoil nutrient levels.

Subsoil depth (cm) 0-10cm (131) Soil test value (enter a number)

- plot by subsoil nutrient level

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NW

N

NE

SW

S

SE

[clear] [undo] [complete]

Map tools: Draw Polygon

Optional Layers | Legend

☐ Road
☐ Vegetation
☐ Rainfall

A polygon can be drawn on the map when the 'Draw Polygon' tool is selected from the Map tools menu. When doing a trial selection, only those trials falling within the polygon will be selected. To draw the polygon, click on the map to define three or more points that form a boundary around the geographic area of interest. To complete the polygon, always click the [complete] text below the map. The polygon boundary must not cross over itself.

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CASE STUDIES



TABULATE DATA

The *BFDC Interrogator* presents a table of 121 treatment series for the selected data (see Figure 3), which meet the final criteria set on the previous page (121 treatment series) giving yield and soil test information. This is an alternative display of data.

Close this table page, then select the 'plot data by soil type' (see Figure 2, page 4).

Figure 3. Soil test-crop response data

152 S trials (121 treatment series)
Soil Test: S KCl40 extractable mg/kg
Soil Sample Depth: 0-10cm

Trial	Treatment series	Soil	Crop	Variety	Yo t/ha	Ymax t/ha	Soil test mg/kg	RY
60001	S rate	Tenosol (Grey)	canola	Narendra	0.776	1.142	5.0	68
60002	S rate	Tenosol (Grey)	canola	Narendra	1.44	1.738	5.8	83
60003	S rate	Tenosol (Grey)	canola	Narendra	2.078	2.385	6.0	87
60004	S rate	Tenosol (Grey)	canola	Narendra	0.793	1.185	6.3	67
60005	S rate	Tenosol (Grey)	canola	Narendra	1.481	1.72	6.3	86
60006	S rate	Tenosol (Grey)	canola	Narendra	0.899	1.322	6.7	68
60007	S rate	Tenosol (Grey)	canola	Narendra	1.012	1.342	7.0	75
60008	S rate	Tenosol (Grey)	canola	Narendra	0.745	1.082	7.0	69
60009	S rate	Tenosol (Grey)	canola	Narendra	2.324	2.634	7.0	88
60010	S rate	Tenosol (Grey)	canola	Narendra	1.07	1.465	4.0	73
60011	S rate	Tenosol (Grey)	canola	Narendra	1.452	1.452	5.0	100
60012	S rate	Tenosol (Grey)	canola	Narendra	1.189	1.198	5.4	99
60013	S rate	Tenosol (Red)	canola	Narendra	1.055	1.056	6.0	100
60014	S rate	Tenosol (Grey)	canola	Narendra	2.0	2.0	6.0	100

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 soil as a different colour (see Figure 4).

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

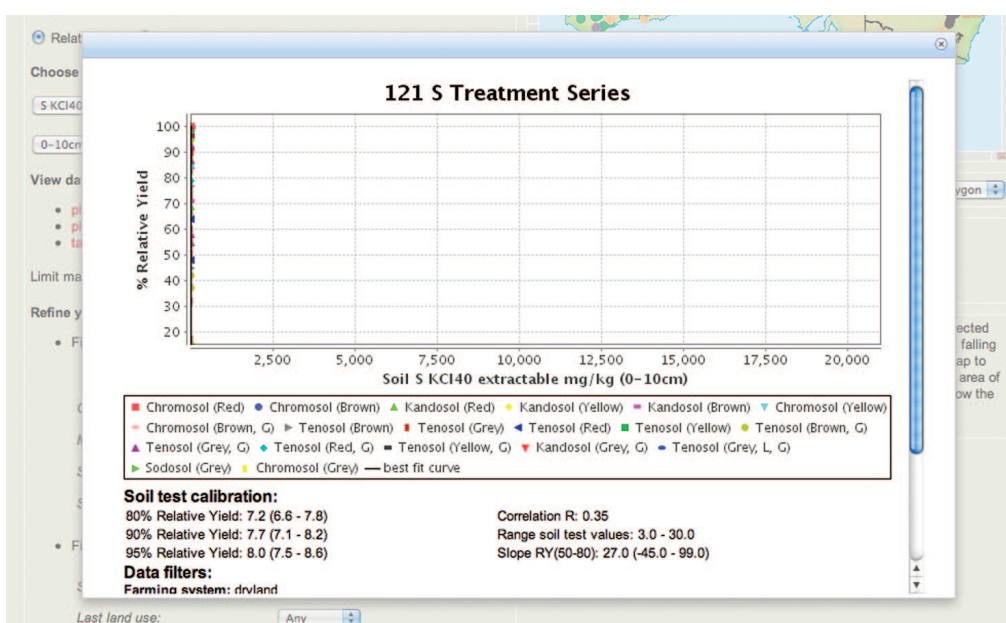
In this case study, the experimental results are graphed relating relative grain yield and KCl_{40} S test in the 0–10 cm soil layer. The plot shows that 121 treatment series met the selection criteria. However, the plot is compressed by an abnormally high value KCl_{40} S in one soil. In this instance, there was a site where free gypsum was present in a deeper soil layer.

Close this table page and return to the **Soil test-crop response calibrations** page. Select **'Limit max soil test value'** and enter a meaningful soil test value, for example **'50'**. Again select **'plot data by soil type'** (see Figure 2, page 4).

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.

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Figure 4. Calibration relationship



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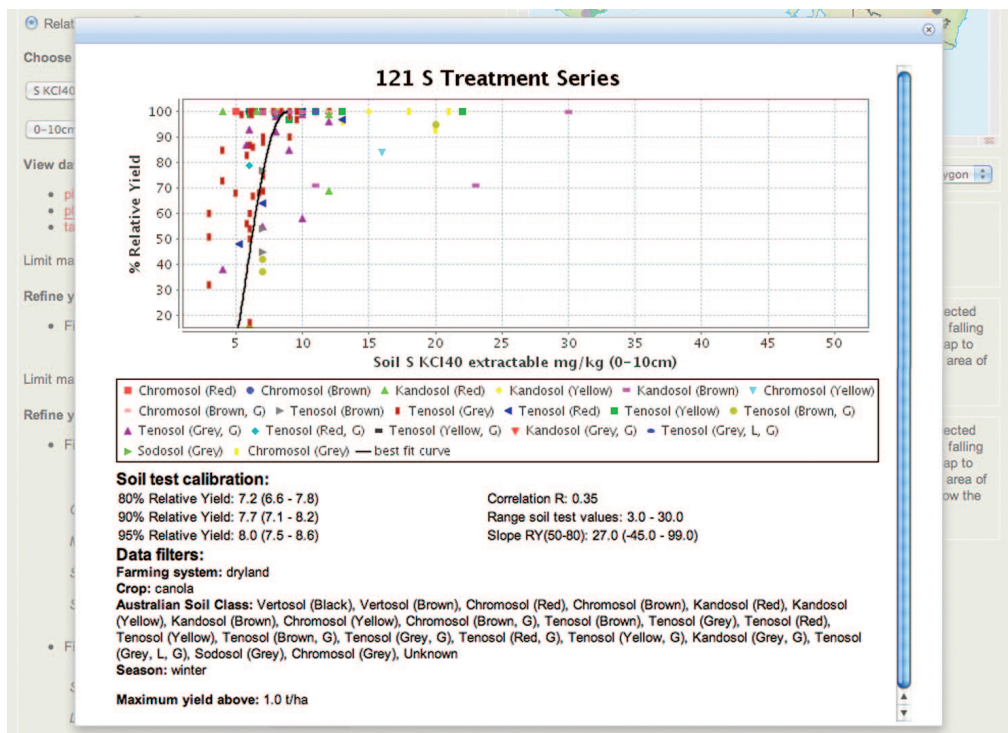
This change has not deleted any sites (still 121 treatment series) as the very high value was in a subsoil and was not plotted in the graph, despite the long x axis. The line of best fit calculated a critical value of 7.7 mg/kg for KCl_{40} S concentration, which was associated with 90% RY (range 7.1-8.2 mg/kg). This was identical to the critical value in Figure 4 (see page 6) presented initially as no data were deleted from the plot (refer to case study: **Potassium in wheat**).

The fit to the data was *moderate* as the 'R' correlation coefficient was 0.36.

Scrolling down the page shows details on the data and filters selected in the case study (see Figure 5).

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.

Figure 5. Alternative calibration relationship



DISPLAYING SUBSOIL CHARACTERISTICS IN DATA PLOT

The *BFDC Interrogator* enables soil test data from sub-soils to be displayed in the calibration graph. The user needs to return to the **Soil test-crop response calibrations** page.

Close this second calibration page (displayed as Figure 5, page 7), and return to the **Soil test-crop response trials** page.

Scroll down to the bottom of that page (see Figure 6). At the bottom of the data filters select '**Subsoil depth (cm)**' and '**20-30cm**'. Also select '**Soil test value**' and enter '**7**'. Click on '**plot by subsoil nutrient level**'.

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Figure 6. Soil test-crop response calibrations (scrolled down)

define three or more points that form a boundary around the geographic area of interest. To complete the polygon, always click the '[complete]' text below the map. The polygon boundary must not cross over itself.

Growing season rainfall: mm mm

Maximum yield: t/ha t/ha

Soil pH_{CaCl2}:

Soil organic carbon: % %

- Filter by any of the trial characteristics below:

Soil texture: Any

Last land use: Any

Subsoil nutrient effect:

This filter is useful only for K and S trials where soil test data have been collected from multiple depths (e.g. 0-10cm, 10-20cm). Choose a surface soil sample depth and enter a suitable soil test (e.g. Colwell K) above. Below, choose a subsoil sample depth and a value for this soil test (e.g. 25 mg/kg) which represents an adequate nutrient level. Click the 'plot calibration' link below to show which surface samples have corresponding adequate or inadequate subsoil nutrient levels.

Subsoil depth (cm) 20-30cm (131) Soil test value 7 (enter a number)

- plot by subsoil nutrient level

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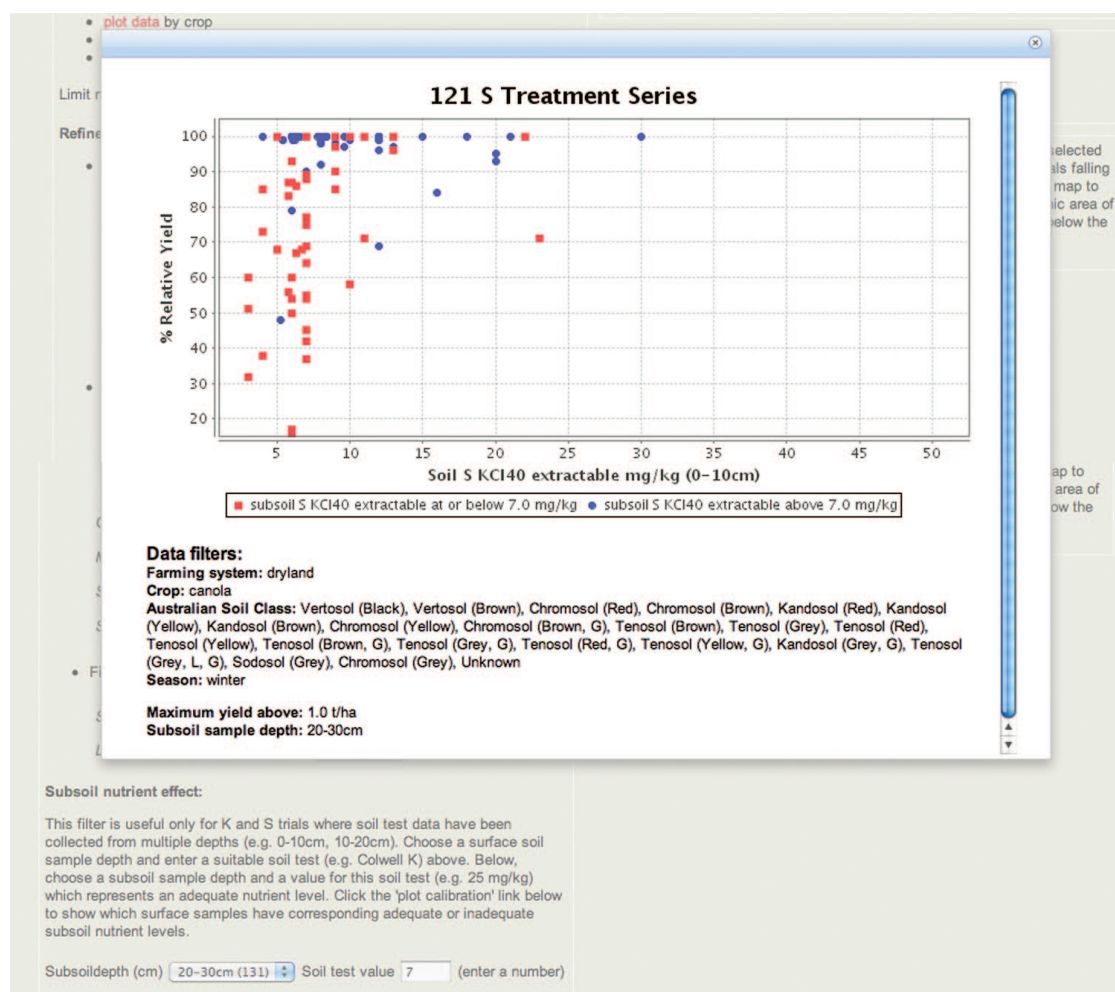


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The plot (see Figure 7) uses colour to describe the sulphur status of the 20–30 cm layer of soil. The sites with KCl_{40}S at or below 7 mg/kg are presented in red, and those above 7 mg/kg are presented in blue. It is clear that some soils with KCl_{40}S below the critical value of 7.7 mg/kg in the 0–10 cm depth, had higher values of sulphur in the 20–30 cm layer. These are the blue points <7 mg/kg in the 0–10 cm and with 100% RY. In these soils, the sulphur concentration was low in soil surface, but there was sufficient sulphur in the deeper soil layer.

Inspection of the data showed that all 121 treatment series were from Western Australia.

Figure 7. Calibration plot — subsoil





CONCLUSION

The critical value of KCL_{40} S concentration in the 0–10 cm depth for canola was 7.7 mg/kg with a critical range of 7.1–8.2 mg/kg, despite some soils having higher KCL_{40} S at the 20–30 cm depth than at the 0–10 depth.

The relationship was *moderate* ($R = 0.36$). The selected data were all from WA.

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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