Improving Phosphorous Management on Upper EP using the DGT Soil Test

Dr Sean Mason[1] and Andy Bates[2]
[1]University of Adelaide, [2]Bates Agricultural Consulting

RESEARCH

Key messages

- **The DGT Soil test can be an accurate predictor of soil P levels in Upper EP soil types.**
- **EP data supports the established DGT critical values for responses to applied P in wheat.**
- **DGT soil P test will be a valuable tool for farmers on EP.**

Why do the trial?

Spectacular fluctuation in fertiliser prices and the increased adoption of variable rate farming techniques have focussed attention on accurate P application at rates that do not compromise yield. Traditional soil tests for P (including Colwell P) struggle to provide accurate estimates of the likely P availability to crops, especially on calcareous soils. However, the Diffusive Gradients in Thin Film (DGT) soil test for phosphorous (developed and modified by Dr Sean Mason) is showing great promise as a tool that is more accurate at predicting P response in wheat than other traditional soil tests, on a range of soil types. Previous lab and field work has shown that more reliable and strategic P fertilisation decisions may be possible if DGT soil test results are utilised as part of the decision making process.

This trial compliments results from replicated field validation trials for the DGT technique across southern Australia. See EPFS 2008, p 150.

How was it done?

Trials sites sown with farmer scale machinery were established across Upper and Central EP to produce paddock scale P response trials. Of the 16 sites, 13 had fertiliser treatments that represented the farmer's standard P rate for 2009, a higher P rate (often double) and a nil P rate. The remaining 3 sites had a standard P rate and nil P strips only. Most of the trial sites (13) were sown to wheat while the remaining sites were sown to barley.

Phosphorus input rates varied from as little as 2 kg/ha P as a fluid fertiliser, up to 28 kg/ha P as a granular fertiliser. Nitrogen and trace elements were balanced on all but 5 trial sites.

Soil samples (0-10 cm) from the nil P strips were taken at sowing and analysed for Colwell P, PBI and DGT.

The cereal crop response to applied P was quantified by taking 3 x 1 m random dry matter plant cuts at late tillering (~GS30) in each of the nil P, standard P and high P strips at each site. Tissue tests at mid – late tillering were performed and analysed for P and other elements.

Grain response to applied P was determined by taking a further 3 x 1 m random plants cuts at maturity and these harvest cuts were threshed to determine grain yield.

Some sites also had yields mapped at harvest to determine if there were any differences with yields obtained by manual harvest. The data obtained by the manual harvest has been reported in this article to provide a uniform method between all sites.

The % relative yield value was used as the measure of response to applied P and is calculated using the following equation.

% Relative yield = Yield (nil plot, 0P)/ Yield (P applied) x 100

If the soil is P responsive, the % relative yield will be less than 90%. The lower the % relative yield the bigger the response and therefore indicating increasing P deficiency.

Table 1 Colwell P and DGT values and associated yield responses to applied P

Site ID	Crop	Colwell P (mg/kg)	PBI	Critical Colwell P* (mg/kg)	CE (DGT) (µg/L)	% Relative yield (~GS30)	% Relative yield (Grain)
Calca	Barley	116	129	33	1025	80	103
Koongawa	Barley	24	83	26	609	84	63
Piednippie Tank	Barley	61	226	38	351	55	NA
Buckleboo	Wheat	42	128	30	1066	57	91
Koongawa	Wheat	29	76	24	731	81	107
Koongawa	Wheat	31	39	15	5328	76	109
Koongawa	Wheat	32	37	15	8007	89	92
Kopi	Wheat	48	97	30	449	54	88
Lock	Wheat	53	132	29	701	57	86
MAC	Wheat	30	91	26	1083	66	81
Mudamuckla	Wheat	25	139	32	394	46	74
Nundroo	Wheat	49	237	38	414	50	97
Piednippie	Wheat	43	200	36	432	69	90
Port Kenny	Wheat	60	208	35	400	56	91
Wirrulla	Wheat	25	163	33	429	45	71
Witera	Wheat	29	109	27	398	58	64

*Calculated from Moody 2007 AJSR
NA - field site not harvested due to severe Rhizoctonia

What Happened?

Early dry matter (~GS30)

By determining the critical Colwell P value using PBI from each site, the Colwell P method predicted that 19% of the sites would have a grain response to applied P, while the DGT test predicted that 69% of the sites would be grain responsive (< 90% RY). The DM cuts revealed that all sites had a positive dry matter response to applied P at mid to late tillering.

From the sites that had two different rates of P applied in addition to the nil strip, it could be determined if the highest P rate was sufficient to maximise yields at both growth stages (GS30 and grain). Out of the 13 sites that had multiple P rates, 8 had a linear response between P rate and yield at GS30 highlighting that insufficient rates of P were used to produce maximum yields. Three sites also had linear grain responses with P rate indicating the problem was highlighted at earlier growth stages. Linear responses to P have also been observed from replicated field trial sites with similar PBI values and similar rates of P used. As relative yield is based on the presumption the maximum yield has been reached, these sites would have lower relative yield values.

Figure 1 shows the relationship between Colwell P test values and % Relative Yield of dry matter at late tillering. The dark circles represent the 2009 EP results and the open circles show the 2006-2009 replicated and field data results. The upper EP data supports the 2006-2009 data in that no significant relationship exists between Colwell P and the response of the crop to applied P (% relative dry matter yield).

Figure 2 shows the significant relationship between DGT and % relative yield dry matter. The EP data supports the results from 25 replicated field trials across grain growing regions in southern Australia. Sites that have had insufficient P rates to maximise yield are highlighted in Figure 2 by having smaller relative yield numbers with respect to DGT values, making these sites fall off the established curve.

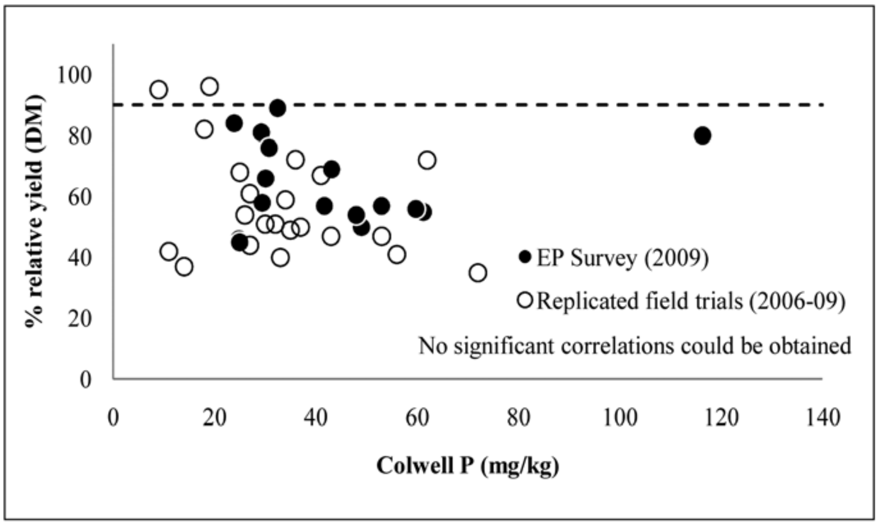

Figure 1   Colwell P relationship with crop response at GS30 (expressed as % relative yield) for the EP survey and replicated field trial data obtained from 2006 through to 2009 (data obtained at time of writing)

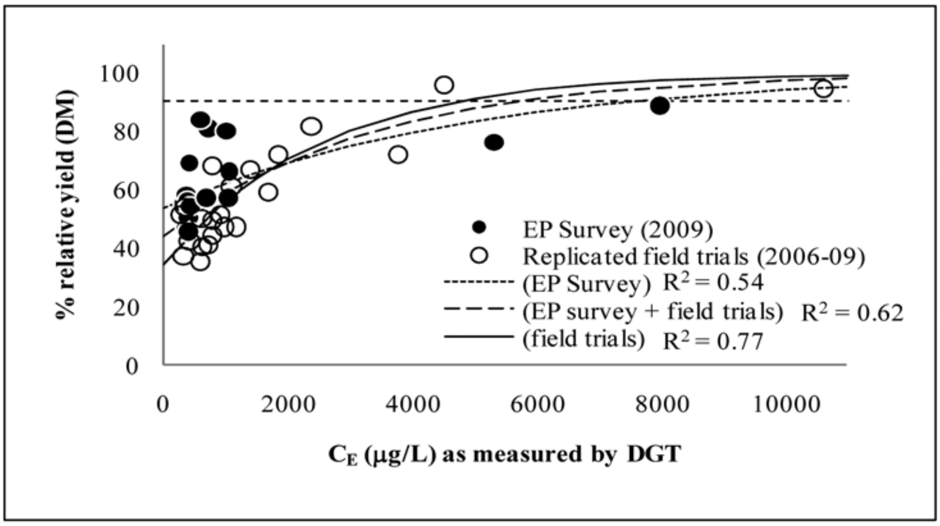

Figure 2   DGT relationship with crop response at GS30 (expressed as % relative yield) for the EP survey and replicated field trial data obtained from 2006 through to 2009 (data obtained at time of writing)

Grain

For all sites grain yield responses were lower compared to yield responses obtained at GS30 apart from one site. The Colwell P plus PBI and the DGT test correctly predicted a similar percentage of the yield responses to applied P (73% and 67% respectively). The decreased predictive capability of DGT in respect to grain response compared to replicated field trials could be due to sites not having a high enough P application rate to maximise yields, as shown from cuts taken at GS30, and therefore they have been classified as non-responsive when in fact they are responsive. These sites again are highlighted in Figure 4 by having lower relative yield values at low DGT values compared to the established data set.

Figure 3 shows the poor relationship between the % relative yield of grain and the Colwell P test results, when compared with the results for DGT (Figure 4).

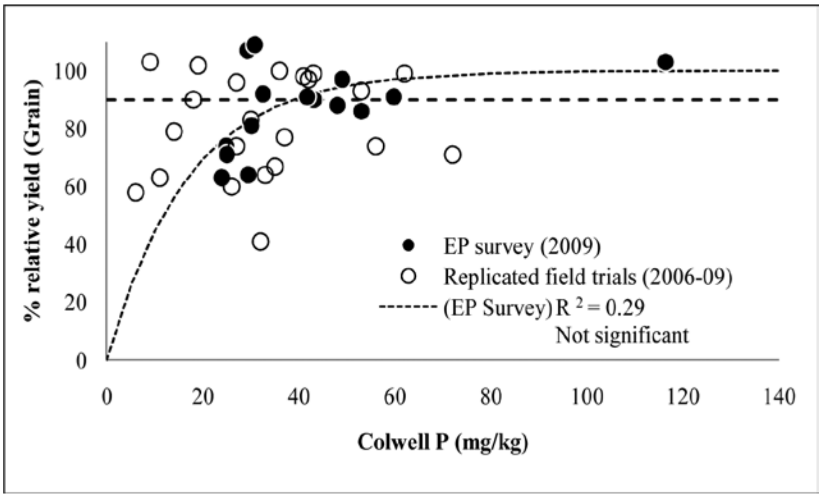

***Figure 3** Colwell P relationship with grain response (expressed as % relative yield) for the EP survey and replicated field trial data obtained from 2006 through to 2009 (data obtained at time of writing)*

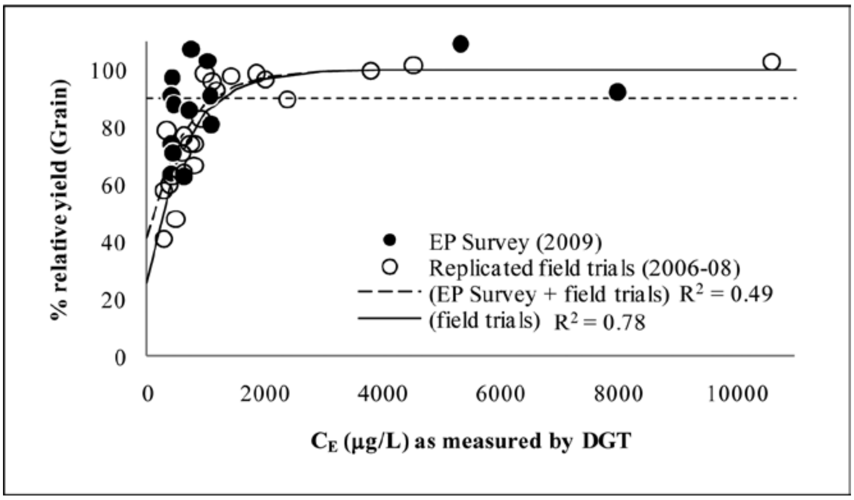

***Figure 4** DGT relationship with grain response (expressed as % relative yield) for the EP survey and replicated field trial data obtained from 2006 through to 2009 (data obtained at time of writing)*

What does this mean?

The early dry matter response to applied P from the 2009 EP sites support results from replicated field trials showing that the DGT test has great promise as a reliable soil test for predicting plant P availability under field conditions when compared with the Colwell P test.

DGT can predict if a soil is P deficient or adequate, and is a valuable tool for assisting the fertiliser P decision process for farmers.

The DGT test cannot specify the rate of P required to maximise yield as fertiliser efficiency is governed by other factors in the soil with the PBI measurement providing a good indication of potential P fixation. Further work is underway to utilise PBI in combination with the DGT test to improve the value of this test to farmers. Preliminary results are encouraging and indicate by combining PBI and DGT measurements the P rate required to maximise yields early on can be predicted.

Additional research is also underway to assess the potential for the DGT test to predict plant responses to other nutrients namely Zn and Mn. The DGT method has also been shown to accurately predict crop response of different crop types (peas, canola and barley) from a small data set. These crop types have shown to have different efficiencies of accessing P in the soil. Results from 2009 trials will help build on these data sets.

GRDC is currently investigating avenues to commercialise the DGT soil test for broadacre agriculture.

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