Phosphorus rate trial and alternative fertilisers

Key findings

- A response to fertiliser after 5 years of no phosphorus applications
- Alternative phosphorus sources such as biosolids, chicken litter or biochar, produced significantly lower yields compared to phosphorus fertiliser
- Biosolids and chicken litter significantly increased leaf and grain zinc concentrations

Why do the trial?

To investigate the impact of conventional phosphorus fertilisers and alternative sources of phosphorus on the grain yield and quality of wheat.

How was it done?

Plot size	1.4m x 10m	**Fertiliser**	Urea @ 50kg/ha at sowing Phosphorus applied as per treatment
Seeding date	12th June 2012	**Variety**	Hindmarsh barley @ 80kg/ha

Trial 1. Phosphorus rate: randomised complete block design with 3 replicates and 4 treatments.

Treatments were re-sown over the same treatments from 2007, 2008, 2009, 2010 and 2011.

Trial 2. Biosolids and chicken litter: randomised complete block design with 3 replicates and 8 treatments.

A single application of biosolids and chicken litter were broadcast prior to sowing in 2008.

No further fertiliser has been added to these treatments. The biosolids + 65kg/ha single super, and chicken litter + 65kg/ha single super treatments had a repeated application of 65kg/ha single super in 2009, 2010, 2011 and 2012. In season foliar phosphorus treatments were added in 2010 and 2011.

Treatments were re-sown over the same treatments areas each year since 2008.

Trial 3. Biochar, phosphorus solubiliser and foliar phosphorus: randomised complete block design with 3 replicates and 12 treatments.

A seed and foliar combination phosphorus treatment plus either 5 or 10kg of granular phosphorus were added treatments for 2011. All other previously applied treatments of biochar or phosphorus solubiliser were repeated in 2011.

Treatments were sown into standing barley stubble from the 2010 trial.

Single superphosphate was used as the standard phosphorus treatment.

The initial Colwell soil phosphorus (March 2007) was 40mg/kg (0 – 10 cm).

The phosphorus buffering index (PBI) was 102.

Plots were assessed each year for grain yield, protein, test weight and screenings (2mm screen).

Assessments were also conducted in 2011 for dry matter yield, leaf and grain nutrient concentrations.

Samples of the biosolids and chicken litter used in 2008 were analysed for nutrient concentration (Table 1).

Table 1. Fertiliser nutrient concentrations (kg/t) of biosolids and chicken litter applied in 2008.

Nutrient	Single superphosphate	DAP	Biosolids	Chicken litter
Nitrogen	0	180	15	43
Phosphorus	90	200	10	8
Potassium	0	0	8	2
Sulphur	110	15	8	6
Zinc	0	0	1	1

Results

In the long term phosphorus experiment (Trial 1) the grain yield ranged between 2.3t/ha (nil phosphorus) to 3.0t/ha (10 or 15kg P/ha). It has taken 6 years of continuous cropping for this difference to develop. Applying 5kg P/ha increased grain yield above the nil, but the 10 or 15kg P/ha rates produced significantly higher yields. This is statistically significant at the 95% level.

It took 5 years of receiving no phosphorus to gain a significant response to the addition of any phosphorus. But after a further year there is a response to phosphorus rate, i.e more than 5kgP/ha. It should be noted that from very early on in the history of the trial, crop dry matter would generally increase with phosphorus fertiliser rate. However, in most cases this did not result in extra grain yield.

In 2012 it meant the highest phosphorus rate of 15kg P/ha had slightly greater screenings.

Protein levels whilst not significantly different, did decline with increases in grain yield in this trial.

Table 2. Trial 1. Grain yield (t/ha), protein (%), test weight (kg/hL), retention (%) and screenings (%) at Hart in 2012.

Treatment	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
Nil	2.3	12.7	69.9	4.9
5 kg/ha P	2.6	12.6	70.0	5.0
10 kg/ha P	3.0	12.6	70.4	4.5
15 kg/ha P	3.0	12.3	69.9	6.2
LSD (0.05)	0.32	ns	ns	1.0

In trial 2 the addition of 6 or 10kg P/ha for the past 5 seasons also significantly increased grain yield compared with no phosphorus. The addition of Crystal Green or a foliar treatment were also higher than the nil treatment. The biosolid or chicken litter treatments alone were lower yielding.

There were no significant differences in grain protein, test weight or screenings which are attributable to treatments.

Table 3. Trial 2. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) at Hart in 2012.

Treatment	(t/ha)	Protein (%)	(kg/hL)	(%)
Nil	2.4	12.9	69.9	3.5
5t/ha Biosolids	2.5	12.8	69.7	3.3
5t/ha Biosolids + 6kg/ha P	3.0	12.9	70.2	4.5
3t/ha Chicken litter	2.6	12.6	69.8	2.8
3t/ha Chicken litter + 6kg/ha P	2.9	13.0	70.4	3.4
10kg/ha	2.8	12.9	69.8	5.3
Crystal Green	2.8	12.9	70.3	3.9
Foliar 2	2.8	12.6	70.5	2.9
LSD (0.05)	0.35	ns	ns	ns

In trial 3 grain yields ranged between 2.0t/ha and 2.6t/ha, with no significant difference in grain quality between the treatments. All treatments receiving 10kg P/ha for the past 4 seasons were significantly higher yielding (2.7t/ha) compared to no phosphorus fertiliser (2.1t/ha). The addition of biochar or foliar phosphorus applications did not increase grain yield or quality.

Table 4. Trial 3. Grain yield (t/ha), protein (%), test weight (kg/hL), and screenings (%) at Hart in 2012.

Treatment	(t/ha)	Protein (%)	(kg/hL)	(%)
Nil	2.1	12.7	69.6	4.4
500kg/ha Biochar	2.0	12.9	69.1	4.1
5kg/ha P	2.4	13.0	69.1	5.9
10kg/ha P	2.7	12.7	68.7	6.2
500kg/ha Biochar + 5kg/ha P	2.2	13.0	69.0	5.7
500kg/ha Biochar + 10kg/ha P	2.6	12.7	69.5	5.1
500kg/ha Biochar + Liquid P	2.4	13.0	68.3	5.3
5kg/ha P + Dow	2.1	12.9	69.5	4.2
10kg/ha P + Dow	2.2	12.9	69.9	4.1
5kg/ha P + Poly P	2.3	12.7	69.8	3.4
10kg/ha P + Poly P	2.6	12.7	69.5	4.9
LSD (0.05)	0.24	ns	ns	ns

Soil phosphorus measurements in Autumn 2012 showed that 10 or 15kgP/ha applied since 2007 had maintained soil phosphorus levels. Soil phosphorus level has significantly declined with the addition of 0 or kgP/ha/yr. A single application of biosolids or chicken litter in 2008 with no further addition of phosphorus fertiliser has produced soil DGT levels between the 5 and 10kgP/ha rates.

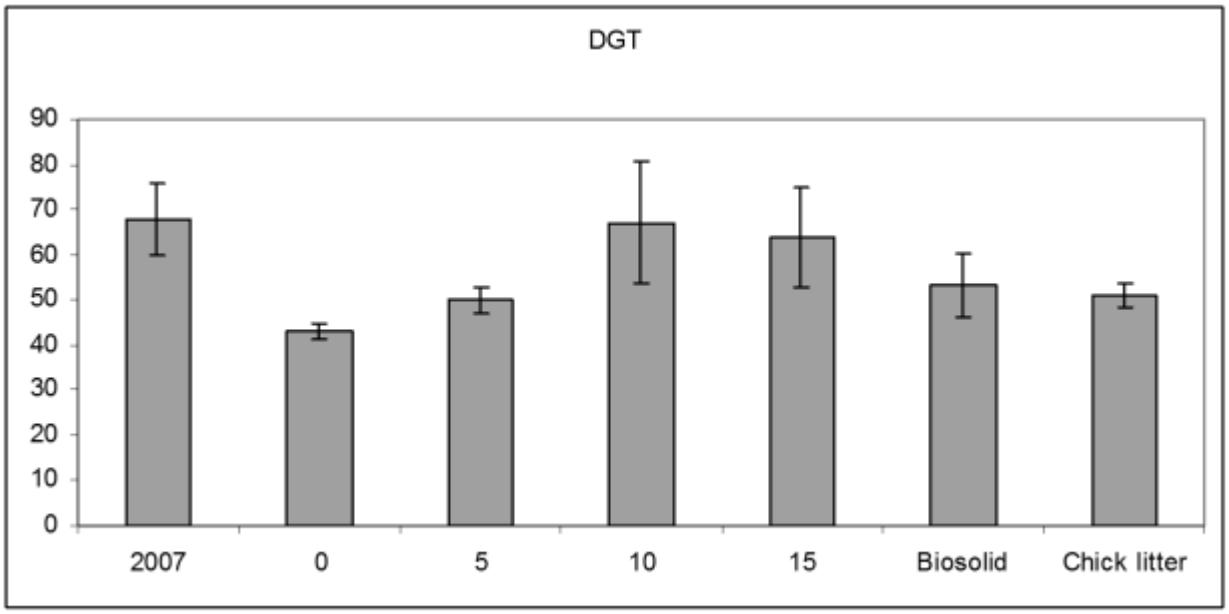

Figure 1: Soil DGT phosphorus (0-10cm) levels measured in the Autumn of 2007 and then in Autumn 2012 for phosphorus rates between 0 and 15kg/ha/yr and biosolids or chicken litter at the Hart field site.

Hart's 'Getting The Crop In' seminar 2012