Utilising Chicken Litter as a Crop Fertiliser – Do We Need to Apply Additional Conventional Fertiliser?

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Abstract
The use of spent chicken litter from chicken meat production facilities as an alternative source of nutrients in broadacre cropping systems is increasing annually. Recent RIRDC funded research and grower observations have indicated reductions in crop vigour on some soils where chicken litter has been applied alone, resulting in crop yield reductions in some instances. The hypothesis is that crop vigour, and yield reductions associated with chicken litter applied without conventional P-based fertilisers, are more likely to occur in phosphorus responsive soils, compared to phosphorus non-responsive soils. To test this hypothesis, two identical trials were established in neighbouring paddocks in the lower North of SA; one on a phosphorus responsive soil as indicated by a range of soil tests, the other on a phosphorus non-responsive soil. Wheat was sown with and without conventional Di-Ammonium Phosphate (DAP) fertiliser in plots treated with chicken litter. Results indicated that phosphorus non-responsive site showed no significant yield or grain quality differences between treatments. At the phosphorus responsive site, plots receiving DAP (with or without chicken litter) yielded significantly higher than those receiving chicken litter alone and the untreated plots. This indicates that chicken litter's low phosphorus availability and/or accessibility is an issue in phosphorus responsive soils. The application of chicken litter without at least some conventional phosphorus-based fertiliser with the seed, can limit crop yields in phosphorus responsive soils

Key Words
chicken litter, phosphorus responsive, broadacre crop

Introduction

The use of chicken litter as an alternative source of nutrients in broadacre cropping systems is increasing annually. Expansion of the chicken meat industry has resulted in greater availability of chicken litter in cropping districts close to Adelaide.

Standard practice has been to broadcast the chicken litter during March-April at rates of 2.5 to 3 tonnes per hectare, with crops subsequently sown during May. These rates of chicken litter supply between 20 to 30kg of phosphorus per hectare.

Even though substantial phosphorus is being applied in the chicken litter, most growers apply additional conventional phosphorus-based fertiliser at seeding. The rationale behind the application of "starter" fertiliser in conjunction with chicken litter is to prevent short term phosphorus deficiency in treated crops given the lower phosphorus availability in the chicken litter, and/or potentially lower accessibility of the nutrient.

Recent RIRDC funded research and grower observations have indicated there are risks in not using conventional fertiliser in conjunction with chicken litter. Reductions in crop vigour have been observed on some soils where chicken litter has been applied alone. Trial results have indicated crop yield reductions in some instances (Craddock and Hollitt, 2010).

In the RIRDC trials, vigour and yield reductions did not occur at all sites. In several instances, non application of conventional fertiliser in conjunction with the chicken litter had no discernible or measurable impact on crop vigour or yield (Craddock and Hollitt, 2010)

Crop vigour reductions are likely to be soil related and due to low phosphorus availability in the chicken litter, or potentially lower accessibility of the phosphorus contained in the product. Phosphorus contained in the litter is mostly present in an organic form and needs to be mineralised before it is available to plants (Dorahy, et.al. 2010). In addition, in modern low disturbance, no-till sowing systems chicken litter is not distributed in the vicinity of the germinating crop seed when applied to the soil surface and incorporated by sowing. This may limit access to nutrients by the establishing crop.

The hypothesis is that crop vigour, and yield reductions associated with chicken litter applied without conventional P-based fertilisers, are more likely to occur in phosphorus responsive soils, compared to phosphorus non-responsive soils.

Methods

To test this hypothesis, replicated trials were conducted in 2010, at Freeling in SA's lower North. Two identical trials were established in neighbouring paddocks; one on a phosphorus responsive soil as indicated by a range of soil tests, the other on a phosphorus non-responsive soil. Test results from a range of soil phosphorus tests conducted by Sean Mason from the University of Adelaide (Colwell P, Phosphorus Buffering Index (PBI), Resin P and Diffuse Gradients in Thin Films (DGT)) are summarised in Table 1.

Table 1: Soil Phosphorus Test data (0-10cm) for Phosphorus Responsive and Non-Responsive Trial sites

Site	Colwell P mg/kg	PBI	Critical Colwell P* mg/kg	Resin P mg/kg	DGT ug/L
Phosphorus responsive	24	35	19	13.72	42
Phosphorus non-responsive	60	95	28	25.33	104
			Critical value	19.2	50

*Calculated from Burkitt et.al. (2007)

All three testing techniques (Colwell + PBI, Resin P and DGT) indicated that the P Non Responsive site was in fact non-responsive. Interestingly Colwell + PBI results indicated that the P responsive site was non-responsive, whilst the Resin P and DGT indicated that the site was P responsive. This highlights an issue faced by growers and agronomists in having the confidence to refine fertiliser decisions based on the accuracy of Colwell soil testing techniques.

The trial design was a randomised block design with three replicates. Wheat was sown with and without conventional Di-Ammonium Phosphate (DAP -NPK 18:20:0) fertiliser in plots treated with chicken litter at 2.5 t/ha. Combinations of chicken litter and conventional fertiliser treatments are detailed in Table 2.

Table 2: Treatments

	Chicken Litter Broadcast Pre-Sowing	**DAP Fertiliser Applied in the Seed Row**
Treatment 1	0	0
Treatment 2	2.5t/ha	0
Treatment 3	2.5t/ha	70kg/ha
Treatment 4	2.5t/ha	30kg/ha
Treatment 5	0	70kg/ha

Raw, straw-based chicken litter was sourced from a commercial chicken meat farm near Mallala in SA. The chicken litter was hand broadcast on the 14th of May 2010 and plots were subsequently direct drilled with 100kg/ha of Gladius wheat using a nine row plot seeder equipped with knife points and presswheels on the 28th of June. An additional 80kg/ha of urea was applied to all plots post emergence.

Plots were harvested with a small plot harvester to assess grain yield, and grain quality analyses were conducted using Viterra's grain testing equipment at their Owen receival site.

Results

Grain yield and quality results in response to combinations of chicken litter and conventional DAP fertilizer at the phosphorus responsive and non responsive sites are detailed in Tables 3 and 4 and summarised in figure 1.

Table 3: Grain yield and quality responses to combinations of chicken litter and conventional fertiliser applications at a phosphorus non-responsive site

Treatment	Grain Protein %	Screenings %	Test Weight kg/hL	Grain Yield t/ha
Untreated	11.83	3.16	69.83	4.86
2.5t/ha CL	11.67	2.58	70.17	4.50
2.5t/ha CL + 70kg/ha DAP	12.50	3.16	69.17	4.56
2.5t/ha CL + 30kg/ha DAP	12.77	3.07	69.67	4.71
70kg/ha DAP	11.70	2.42	70.50	4.81
LSD (P=0.05)	n.s.	n.s.	n.s.	n.s.

Table 4: Grain yield and quality responses to combinations of chicken litter and conventional fertiliser applications at a phosphorus responsive site

Treatment	Protein %	Screenings %	Test Weight kg/hL	Yield t/ha
Untreated	9.83	4.89	66.50	2.39
2.5t/ha CL	9.83	4.26	67.33	2.48
2.5t/ha CL + 70kg/ha DAP	10.03	3.85	67.83	2.98
2.5t/ha CL + 30kg/ha DAP	9.87	4.77	67.00	2.60
70kg/ha DAP	9.37	3.15	69.00	3.05
LSD (P=0.05)	0.36	1.72	n.s.	0.49

Discussion

The phosphorus non-responsive site showed no significant yield or grain quality differences between treatments.

At the phosphorus responsive site, plots receiving 70kg of DAP (with or without chicken litter) yielded significantly higher than those receiving chicken litter alone and the untreated plots.

The plots receiving 30kg/ha of “starter” DAP in conjunction with the chicken litter yielded more than the chicken litter only treatment, but less than the chicken litter + 70kg of DAP (but was not significantly different from either treatment).

This indicates that chicken litter’s low phosphorus availability and/or accessibility is an issue in phosphorus responsive soils. The application of chicken litter without at least some conventional phosphorus-based fertiliser with the seed, can limit crop yield in phosphorus responsive soils even when the fertiliser fixation potential appears low as indicated by low PBI measurements.

Conversely, in phosphorus non-responsive soils, the results indicate no requirement for conventional P-based fertiliser with the seed. This indicates potential for chicken litter to be used alone, without yield penalty in phosphorus non-responsive soils.

Another observation is that a “starter rate” of 30kg per ha of DAP may not be sufficient to completely overcome the risk of P deficiency in a highly phosphorus responsive soil.

Accurate identification of the phosphorus responsiveness of soils is required to provide confidence in making decisions on whether to use or not to use conventional fertiliser in conjunction with chicken litter applications.

If phosphorus responsive and non-responsive soils can be accurately identified, growers and agronomists can make informed decisions on the necessity for conventional fertilisers to be applied in conjunction with chicken litter, or whether chicken litter could be applied alone.

This supports the need for research into improved soil phosphorus tests including Diffuse Gradients in Thin Films (DGT) phosphorus tests to accurately identify the phosphorus responsiveness of soils.

Commercial availability of DGT soil testing technology will potentially improve decisions in relation to the need to use (or not use) conventional fertilisers with organic by-products such as chicken litter in Australian broadacre farming systems.

If growers are unsure of the phosphorus responsiveness of paddocks intended for treatment with chicken litter, the application of conventional phosphorus-based fertiliser when the crop is sown is recommended.

Conclusion

Low phosphorus availability and/or low accessibility associated with chicken litter applications in no-till sowing systems can limit grain yield in phosphorus responsive soils.

In phosphorus non-responsive soils, low phosphorus availability and/or low accessibility associated with chicken litter does not appear to influence crop yields.

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References

Craddock TD and Hollitt JF (2010) Piloting chicken litter usage in broadacre cropping; Setting research directions, RIRDC Final Report

Dorahy C, Dougherty W, Chan Y and Waters D (2010) Using recycled organics and manures in grain cropping systems; Prime fact 1008, Industry and Investment NSW

Burkitt LL, Moody PW, Gourley CJP and Hannah MC (2007) A simple phosphorus buffering index for Australian soils, Australian Journal of Soil Research 40(3) 497 - 513