Three year evaluation of liquid and granule nutrition packages at Tuckey

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Almost ready

Location:
Tuckey
Jason & Julie Burton
Rainfall
Av. Annual: 330 mm
Av. GSR: 235 mm
3 Yr Av Total: 319 mm
3 Yr Av GSR: 217 mm
Yield
Potential: (3 yr av.) 3.97 t/ha (W)
Actual: (3 yr av.) 2.29 t/ha (control)
Paddock History
2014: Wheat
2013: Wheat
2012: Wheat
2011: Angel medic pasture
Soil Type
Sandy loam
Soil Test
C_{DGT} 36
Predicted Response (DGT) 81%
Plot Size
50 m x 2 m x 3 reps
Yield Limiting Factors
Early finish

Key messages

- **Liquid N at sowing can improve crop emergence and early vigour, particularly under dry conditions.**
- **The addition of trace elements and flutriafol fungicide does not provide increases in emergence, tillering or final yield.**
- **Burton Brew provided yield and gross margins above that of other liquid NP treatments.**
- **Higher input costs of liquid NP treatments resulted in those treatments being less profitable than traditional granule treatments over a three year period.**

Why do the trial?

The decision to introduce liquid technology to support a grower's granule fertiliser program in 2011 prompted the establishment of split paddock trials in that season, resulting in a $100/ha gross margin benefit in the liquid NP + granule NP (row support) system over the traditional granule MAP + Urea system used on a farm at Tuckey. This gross margin increase prompted an investigation into what components were responsible for the benefit, thus the establishment of this trial site in 2012. Results from the 2012 season demonstrated yield benefits from liquid fertilisers, with liquid N being a key driver to increased productivity. It was deemed necessary to replicate this trial for another two seasons to determine the outcomes under different seasonal conditions and to determine if there is any cumulative effect of fertiliser treatments.

How was it done?

The trial was established on a uniform grey brown loam top soil over soft limestone subsoil, with a 2012 base Colwell P of 36 mg/kg (sufficient) and nitrate N of 36 mg/kg (sufficient at time, but no individual treatment soil testing was carried out prior to sowing in 2013 and 2014). Sown in May each year with Mace wheat, the replicated trials consisted of a number of liquid, granular, and liquid/granule combination treatments of nitrogen (N), phosphorus (P), trace elements (te) and in-furrow fungicide (fung) designed to establish which of these components has the greater effect on final yields. The treatments are summarised in Table 1. The treatments were identical each year and were sown plot on plot to determine any cumulative effect.

What happened?

Visual differences in emergence and early vigour were observed in the first two years of the trial, with treatments containing liquid N and the complete liquid treatment establishing quicker and demonstrating increased early vigour. This was not observed in the final year, with no clear advantage in liquids under wet seeding conditions. Emergence and establishment was marred in the final season due to inaccurate seed placement caused by pugging of the plot seeder boots, making it difficult to accurately measure emergence. Over the 3 seasons the granular nitrogen liquid phosphorous (granNliqP) treatments were the poorest performers in terms of emergence, whilst the addition of trace elements and fungicide had no impact on emergence and no advantage was evident with full liquid system over full granular system.

Annual tiller counts reflected seasonal variability with treatments containing liquid N providing increased tiller numbers in the dry conditions of 2012 (refer to EPFS Summary 2012, p 112), whilst granule N treatments provided an advantage with high soil moisture in 2013 (refer to EPFS Summary 2013, p 132). Insufficient N due to 2012 crop removal under liquid treatments was thought to contribute to 2013 results, and 2014 demonstrated little difference between treatments in a season where N replacement levels were increased with higher soil moisture. The three year mean suggested that there was no difference in tillering across liquid and granule treatments, although nil fertiliser was penalised severely (Table 1). The addition of trace elements also had little effect, as did the addition of fungicide, however it was found that flutriafol applied to granule fertiliser (MAP) reduced tiller numbers to that of liquid flutriafol applied in furrow (Table 1, treatments 18 and 17 respectively).

Table 1 Three year mean wheat emergence (plants/m²), tiller count (tiller/m²), grain yield (t/ha), Water use efficiency (WUE), (kg/ha/mm) and gross margins ($/ha) in response to fertiliser treatments

Treatment	Treatment descriptor	Emergence (plants/m²)	Tiller count (/m²)	Grain yield (t/ha)	WUE	Gross margin ($/ha)
1	granN granP (T1)	169	249	2.6	9.9	650
2	granN granP +fung -te (T2)	169	249	2.5	9.6	624
3	granN granP -fung +te (T3)	163	253	2.5	9.8	629
4	granN granP +fung +te (T4)	159	253	2.3	8.6	604
5	liqN liqP -fung -te (T5)	173	245	2.5	9.6	547
6	liqN liqP +fung -te (T6)	174	246	2.4	9.6	537
7	liqN liqP -fung +te (T7)	160	254	2.5	9.7	543
8	liqN liqP +fung +te (T8)	165	237	2.5	9.9	556
9	liqN granP -fung -te (T9)	163	250	2.5	9.9	598
10	granN liqP (T10)	154	252	2.6	10.0	577
11	liqN granP -fung +te (T11)	167	251	2.5	9.9	589
12	granN liqP -fung +te (T12)	153	244	2.6	9.9	569
13	liqNliqP +fung +te (T13)	161	245	2.5	9.9	533
14	granN(20) granP(12) -fung -te (T14)	164	245	2.5	9.8	628
15	Burton double (T15)	150	255	2.8	11.1	613
16	liqN liqP(6) +fung +te (T16)	160	232	2.5	9.8	559
17	granN granP(12) +fung +te (T17)	165	260	2.5	9.9	621
18	granN granP +gran fung+H20 +te (T18)	159	235	2.6	10.0	630
19	nil fert (T19)	171	223	2.3	9.1	631
20	nil fert +fung (T20)	162	228	2.3	8.9	614
21	Burton Brew (T21)	157	261	2.6	10.2	660
22	Burton Brew II (T22)	164	232	2.5	8.1	583
LSD (P=0.05)		*12.73*	*21.91*	*0.17*	*0.86*	*34.8*

Note all treatments contain 20 units of N and 8 units of P unless specified otherwise in the description, except 2014 where all treatments had 30 units of N. Granule treatments use MAP + Urea, and liquid treatments use liquified urea and phosphoric acid, excluding T13 which uses UAN and APP. Trace elements (te) consists of Zn and Mn @480 g/ha and Cu @ 193 g/ha as sulphate, except for treatment 13 which is EDTA chelate. Fungicide consists of flutriafol @ 100 g/ha ai as a liquid, except for treatment 18 which has a coating on granule fertiliser (MAP). Furthermore, the Burton Blend contains N-(6liquid+14granule), P-(6liquid+2 granule), Zn Mn 480 g, Cu 193 g, using MAP and Urea for granule components. Burton Double N-(12liquid, 14granule), P-(12liquid+2granule), Zn Mn 1000 g, Cu 420 g, and Burton II N-(12liquid+8granule), P-(4liquid+4 granule), Zn Mn 480 g, Cu 193 g

Favourable seasons resulted in trial yields well over two tonnes per hectare each year resulting in large annual nutrient removals, particularly N. In 2012 liquid N drove yield advantages despite being sown on a medic pasture, whilst it was granule N and liquid P that delivered the highest yields in 2013. Last season mirrored the long term results with all liquid, granule and combination treatments yielding similarly, with nil fertiliser considerably lower. Notably the differences between full liquids and granule district practice seen in 2012, was not realised. Despite benefits of the inclusion of fungicide and trace elements to a liquid system evident in 2012 (data not shown), the addition of trace elements and fungicide did not provide conclusive benefits long term, nor did in furrow liquid fungicide over granule coated.

Differences in grain quality were negligible with no effects on pay grade in 2012, and only Burton Brew and Burton II recording higher pay grades in 2013 due to test weight and screenings. Test weight and screenings again showed differences in 2014, but did not cause an overall change in grade.

Higher yields that favoured liquid treatments in 2012 didn't translate into high profits, and in 2013 liquid treatments suffered poor returns compared with granule treatments, reflective of a lack of yield response. Again in 2014 the lower input costs of granule treatments made them generally more cost effective than full liquids and nil fertiliser, and similar to the combination treatments of liqN granP and granN liqP. However, Burton Brew (T21) remained a standout, out yielding many of the granule and liquid treatments. Overall gross margins told a similar story with the granule system giving higher returns than those treatments containing liquid P (full liquid & granNliqP), and similar to those of nil fertiliser and liqNgranP, and the Burton brew returning more than most other granule and liquid treatments (Table 1).

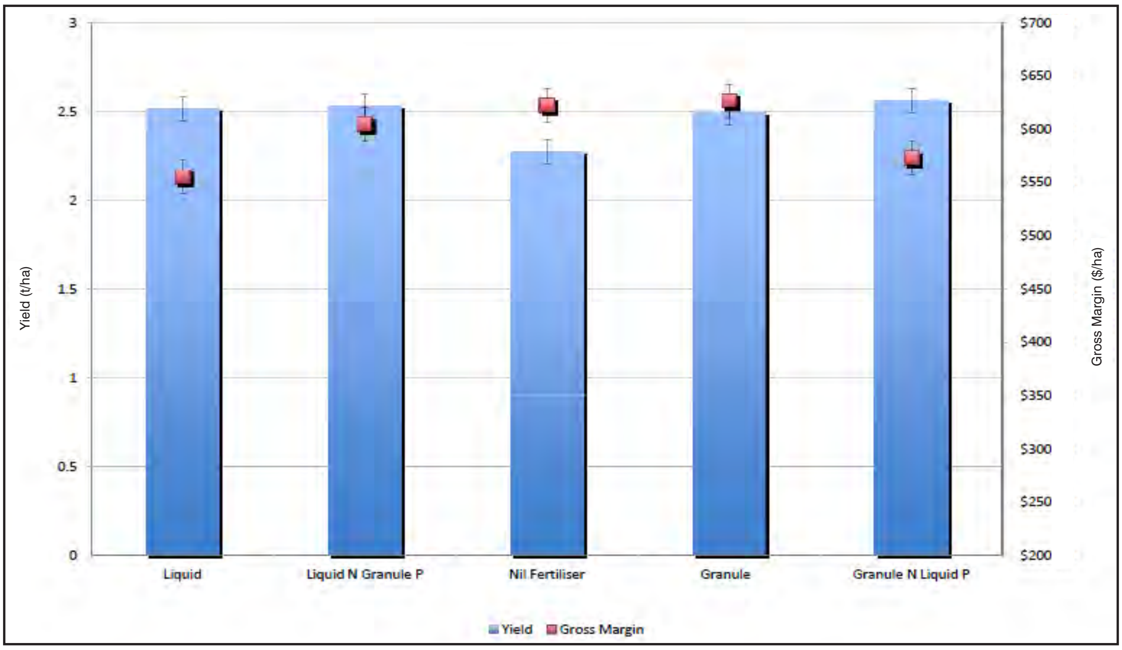

Figure 1 Three year mean wheat yield (t/ha) and gross margins ($/ha) of liquid NP, liquid N granule P, nil fertiliser, granule NP and granule N liquid P treatments. The bars represent the standard deviation about the mean

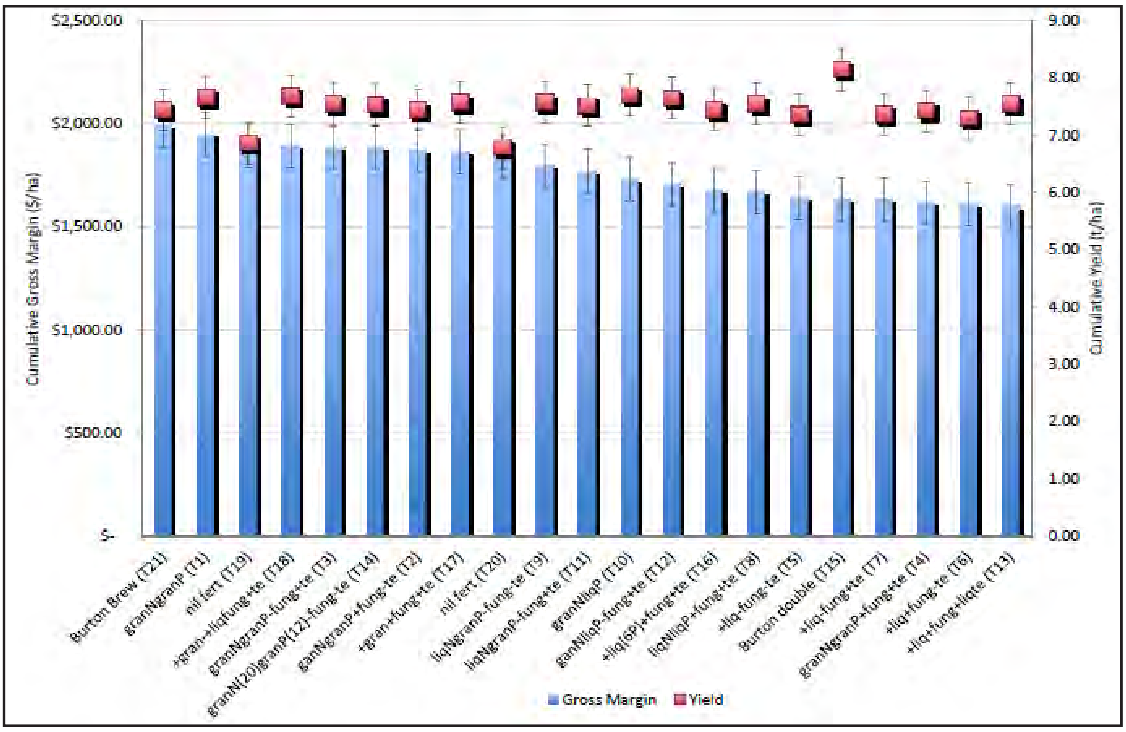

Figure 2 Three year cumulative wheat yield (t/ha) and gross margin ($/ha) of individual treatments. The bars represent the error about the means. Burton II has been removed as was only included in year 2 & 3

What does this mean?

Results from initial split paddock trials near the site and from the first year of this trial suggested the potential for large gross margin gains with row support and full liquids systems over traditional granular fertiliser systems at sowing. Despite these results, it was hypothesised at the onset of this three year trial that full liquid systems would not be a cost effective option, but rather a traditional fertiliser regime enhanced through the use of liquid technology would see the greatest returns to the grower. This trial has so far given some support to that hypothesis in that full liquids have returned poorly over three years, and it has been the 'row support' option of a granular based fertiliser enhanced with liquid N that has given the most marked responses.

Liquid N was a common theme throughout the trial, with year one showing large improvements in crop emergence and early vigour under dry soil conditions, which followed through to biomass gains at mid tillering. The two subsequent seasons delivered similar responses up until tillering, but with good soil moisture levels that would remain throughout winter, granule N treatments performed as well as liquid N treatments in terms of grain yield.

The incredibly high soil moisture levels experienced in 2013 and the winter months of 2014 were contrasting to 2012 and provided an environment favourable for the release and movement of N from granule based fertiliser. Toxic salt effects of granule based fertiliser that can reduce crop emergence in dry conditions were avoided by liquid treatments, making them more favourable in dry start conditions.

In the second year of the trial, liquid treatments experienced severe N deficiency at the beginning of tillering which disadvantaged their development and yield potential throughout. This is thought to be caused primarily by nutrient removal through higher yields in the year prior. It is also hypothesised that the relatively low doses of N coupled with wetter than normal conditions may have caused liquid N to leach more quickly than granule N, although there is no data to support this. A decision was made not to treat individual plots according to nutrient removal, but rather ensure each plot received the same number of units of each nutrient, regardless of fertiliser form, a decision that reduced variability within the trial, but penalised those treatments that initially performed well. To address this in the final season, all plots received an additional 10 units of N at time of sowing, and a further 12 units as UAN mid tillering, taking the total N to 42 units rather than 20 as in previous years. While there was little difference in tillering between liquid and granule treatments over the duration of the trial, it was clear that insufficient nutrition (nil fertiliser) reduced tiller numbers consequently leading to yield penalties.

An expectation at the beginning of the project was that the addition of trace elements would provide some level of improvement in crop vigour and yield potential given the critical deficiencies detected in soil tests and the observed benefit of applying zinc particularly early in the crops life. While advantages were observed in 2012 when trace elements and fungicide were added to liquidNP treatments, this did not continue throughout the duration of the trial with the addition of trace elements having no impact on emergence, tillering or final yield.

The move to liquid fertiliser technology has to have some benefit in yield; it requires an investment over and above that required for traditional fertiliser systems that must have a return. Precursor split paddock trials and 2012 data clearly showed favourable improvements in grain yields under liquid fertiliser, however this was not supported in the subsequent seasons, resulting in the overall performance of liquids being similar to that of traditional granule treatments. Importantly, after three successive seasons a penalty for nil fertiliser is evident, and it can be hypothesised that this is likely due to inputs in each of the individual seasons, and cumulative draw down on soil reserves as a result.

Given the negligible differences in yield between treatments it is logical that there were no differences in final water use efficiency (WUE). The dry season of 2012 showed liquid treatments to be more effective than granules at converting soil moisture into grain yield, again reaffirming the strength of liquids in dry seasons. Overall WUE values were low indicating that the 2013 and 2014 seasons were not limited by water, rather by nutrition or some other factor. Analysis of the three year mean effect of fertiliser form showed that nil fertiliser and traditional granule nutrient input have provided the greatest return given their low input costs. The relatively high costs of liquid treatments, particularly a full liquid, without an improvement in yield, means returns are well down compared with traditional granule systems. The exception to this is when treatments are analysed individually, which shows the Burton Brew, a full liquid treatment supporting a granule system (row support), was one of the highest performers in terms of tillers, yield, WUE and gross margin.

The overall objective of this study was to determine whether the considerable increases in yield and profitability observed in farmer based split paddock trials which compared traditional granule regimes to a row support system using Burton Brew, could be replicated under trial conditions. The outcomes of three years of trials ultimately does not conclusively support these observed benefits, however the Burton Brew has tended to provide increased yields and profits over many liquid and granule treatments. Full liquid systems have not provided a yield benefit resulting in lower bottom line returns over the period, indicating their lack of suitability at this site. No conclusive benefits were seen in the addition of trace elements, nor with the addition of in furrow fungicides, outcomes that tend to dispute what many observe in the paddock. It is likely that an in furrow fertiliser system that incorporates the use of liquid NP, trace elements and fungicide, coupled with granule NP will provide economic advantages over regimes that use granule or liquid alone.

Acknowledgments

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SPRAY GRO LIQUID FERTILIZERS

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