Alternative Fertiliser Project
Final Report 2014
Granite Borders Landcare / MLA

Background

Over the past 10 to 15 years fertiliser prices have increased significantly and the livestock grazier's ability to pay has decreased. There is also the perception that the traditional fertiliser usage is not giving the response in both pasture and livestock growth rates that the graziers have expected and presumably have been obtaining in the past. This has also been complicated by the fact that seasonal conditions during that time have been unfavourable with primarily dry/drought periods prevailing for the majority of the period. This obviously reduces pasture growth and therefore the ability for visual favourable responses to fertiliser inputs. This then leads people to question their traditional use of fertiliser and look towards cheaper alternatives that may lead them back to improved long term viability prospects. Unfortunately for the land manager there is a massive plethora of products peddled throughout the market place with little or no independent scientific evidence to show that they produce the results claimed or the economics of using such products.

This project is an attempt to put some independent science behind a limited number of nutrients and/or products that has had earlier science attached to their preceding use. Those chosen was based on local knowledge and determined by the one's most likely to give a pasture response.

Method

The project consisted of 5 properties located in the northern part of the NSW Northern Tablelands (Deepwater, Tenterfield, Liston & Wylie Creek [the latter amalgamated in the last year]). They were selected to cover the major range of soil types, fertiliser histories, pasture types and total average annual rainfall throughout the district. To this effect soil types covered were a brown clay loam (granite), sandy loam (blue granite), brown/grey sandy clay loam (granite), grey clay ("trap") and a grey loamy sand (coarser granite). Fertiliser histories ranged from annually fertilising with 125 kg/ha single superphosphate to no fertiliser in the last 15 years. Pasture types varied from improved introduced species on the better fertilised properties, through improved naturailsed species, introduced tropical grass/temperate legume species to improved native species as the fertiliser history declined. Annual average rainfall ranged from approximately 825mm to 1100mm.

There was a total of 17 different nutrients/products which were used in different combinations to make 36 diverse treatments across all sites with only 20 common treatments over the 4 main sites (Wylie Creek had 4 common treatments) including control of nil fertiliser. Plot size was 5 m long x 2 m wide with 3 replications. Treatments were only applied once at the beginning of the trial. All treatments were applied to sites between October/December 2011.

Products/nutrients used were as follows:

Product	Description	Rate/ha	Cost/ha
Single Superphosphate	traditional fertiliser containing 8.8% total P; 8.6% available P; 11% sulphate S; 20% Ca	125 kg/ha	54.38
Molybdenum Superphosphate	**traditional fertiliser as above plus 0.05% Mo**	**125 kg/ha**	**63.13**
Muriated Potash	fertiliser supplying potassium 50% K	50 kg/ha	35.75
NTS Guano™ Granules	**fossilized seabird droppings; total P ~12% Ca 25 – 30%; C 6.5%; particle size 2 – 5mm**	**250 kg/ha**	**284.50**
NTS Soft Rock™	colloidal calcium phosphate; total P 8 – 9%; soluble P 0.83%; Si 15 – 25%; K 0.7%; Ca (as phosphate) 19.3%	350 kg/ha	280.00
BioAgPhos	**reactive phosphate rock treated with microbes total P 12%; available P <6%; sulphate S 1% Ca 27%**	**80 kg/ha**	**38.40**
Gypsum	contains sulphate S 10 – 15%; Ca 12.5 – 19%	80 kg/ha	12.00
NTS Dia-Life™	**micronised diatomaceous earth; silicon 12.5%; silica >25%; B 0.7%**	**2 litres/ha**	**27.46**
NTS Stabilised Boron Granules™	active min. 90%; humic acid 40% min.; effective B (as B_2O_3 dry basis) 3%	20 kg/ha	67.94
NTS Soluble Humate Granules™	**humates from brown coal; water soluble K humate min. 70%; K (dry basis) 8.5%); solubility 85%; moisture 15%**	**10 kg/ha**	**29.71**
Compost	Mara Seeds compost N 1.88%; P 2.66%; K 1.54%; S 0.64%; C 20.5%; Ca 8.65%	200 kg/ha & 5 t/ha	25.00 625.00
Biochar	**made & supplied by Mara Seeds; analysis unknown**	**5 t/ha & 10 t/ha**	**3000.00 6000.00**
Cement	used as a source of silicon; silica 21% (SiO_2)	100 kg/ha	45.00
Feedlot manure	**sourced from Rangers Valley Feedlot; P 0.21% N 1.5%; K 0.49%; S 0.11%; Ca 0.65%; OC 18.7%**	**5 t/ha**	**190.00**
NatraMin Cal S	Bio active mineral fertiliser; total P 0.06%; S 5.8%; K 2.0%; Si 17.3%; Ca 10.7% plus some trace elements	400 kg/ha	154.00
Urea	**source of N 46%**	**125 kg/ha & 250 kg/ha**	**85.25 170.50**
Charcol	source of carbon and other nutrients; 2 grades used; analysis not available	5 t/ha & 10 t/ha	n.a.

Herbage mass harvesting interval varied depending on the seasonal conditions at each site with 2 sites receiving 3 harvests during 2012 (summer, winter, spring), one site 2 harvests in 2012 (autumn, winter) and 2 sites had one harvest each (summer 2012 & winter 2013).

Selected sites were soil tested for both chemical and biological aspects (replications were bulked) for a range of nutrients and biological activity towards the end of the project period (2013) to ascertain if the application of nutrients through the treatment were effective in raising their soil levels. This is done through comparing the original levels as indicated in the control (nil fertiliser) with that obtained under each treatment.

Results and Discussion

Treatment application was in late 2011 in relatively improved seasonal conditions throughout that summer/autumn period. Mid to late 2012 and early 2013 seasonal conditions deteriorated limiting the responses likely from the treatments.

Soil types varied considerably from medium/coarse granite through to fine/blue granite and a trap/ podsolic soil – in other words from a sandy loam to a clay loam. The fertility of the soils varied in their phosphorus buffering index (PBI) and levels of phosphorus (P) and sulphur (S) – critical P levels as indicated by the PBI varied from 25 mg/kg to 80 mg/kg, P levels from 23 mg/kg (lowest critical P levels) to 35 mg/kg (highest critical P levels) and S levels 2.8 to 8.4 mg/kg. The levels of P in particular and S to a lesser degree, correlated reasonably well with the cooperators fertiliser history. Given the above soil indicators it was envisaged that a response to the applied treatments were not unreasonable.

Herbage mass harvests were aligned with autumn, winter and spring seasons. An analysis (at $P < 0.05$) of the herbage mass data overall at each site indicated no significant difference (F value does not exceed F critical value) between any of the treatments. However at 3 sites a small significant difference did appear between treatments within a harvest. At the Tenterfield 1 (figures 1 & 2) site the difference appeared in harvest one with Urea 250 kg/ha followed by Biochar and Urea 125/ha. The rest of the treatments were relatively similar. Tenterfield site 2 (figures 3 & 4) saw significant differences appearing in harvest 3 where potash, guano, biochar + single superphosphate, humate + single superphosphate, biochar and single superphosphate being similar at the highest yields. The Deepwater site (figures 5 & 6) also resulted in significant differences appearing in harvest 3 with the best treatments of highest yields being biochar + single superphosphate, potash + single superphosphate, biochar, and cement + single superphosphate + boron. There was no significant differences detected (at $P < 0.05$ level) at the other sites. (figures 7, 8 & 9).

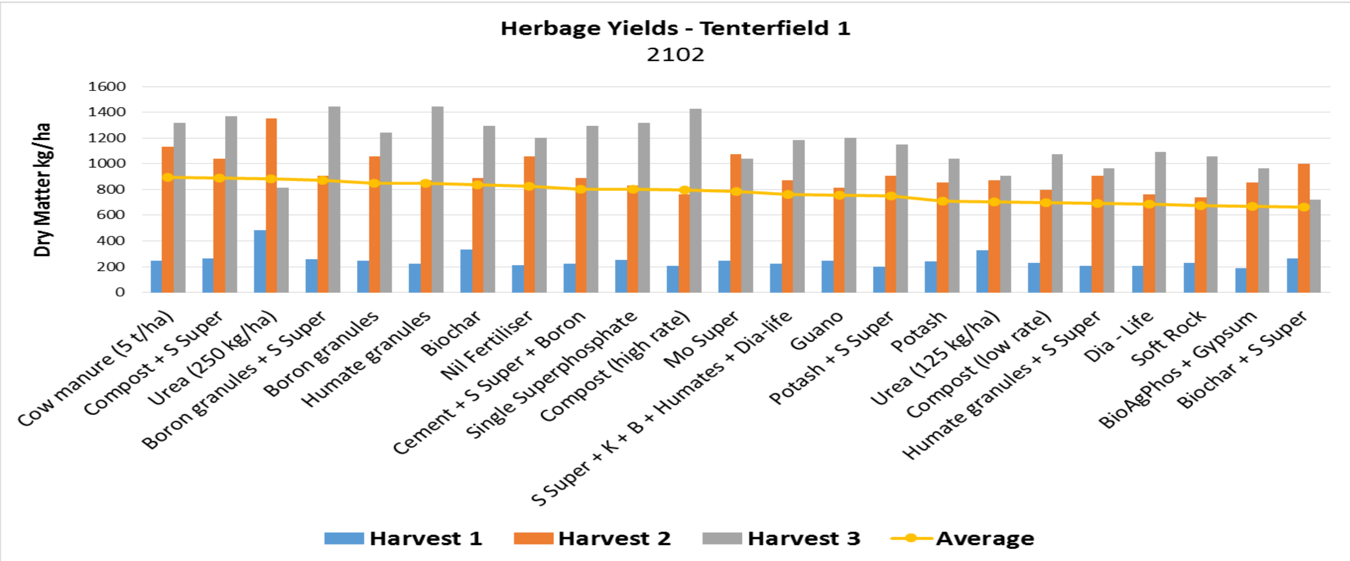

Figure 1.

Tenterfield site 1 - Herbage yields showed no significant difference between treatments either overall (average), harvest 2 or harvest 3. A significant difference did appear in harvest 1 – see figure 2 below.

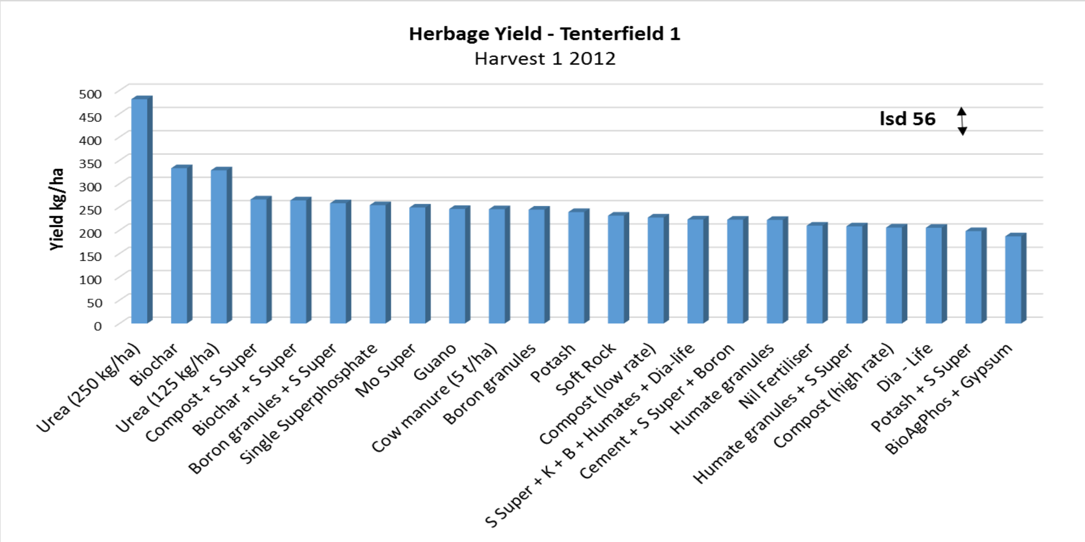

Figure 2.

Tenterfield site 1 - Harvest 1 shows a significant difference in herbage yield to the treatment Urea at the high rate (250 kg/ha) from all other treatments. Biochar and Urea (125 kg/ha) were also significantly higher yielding than the rest of the treatments.

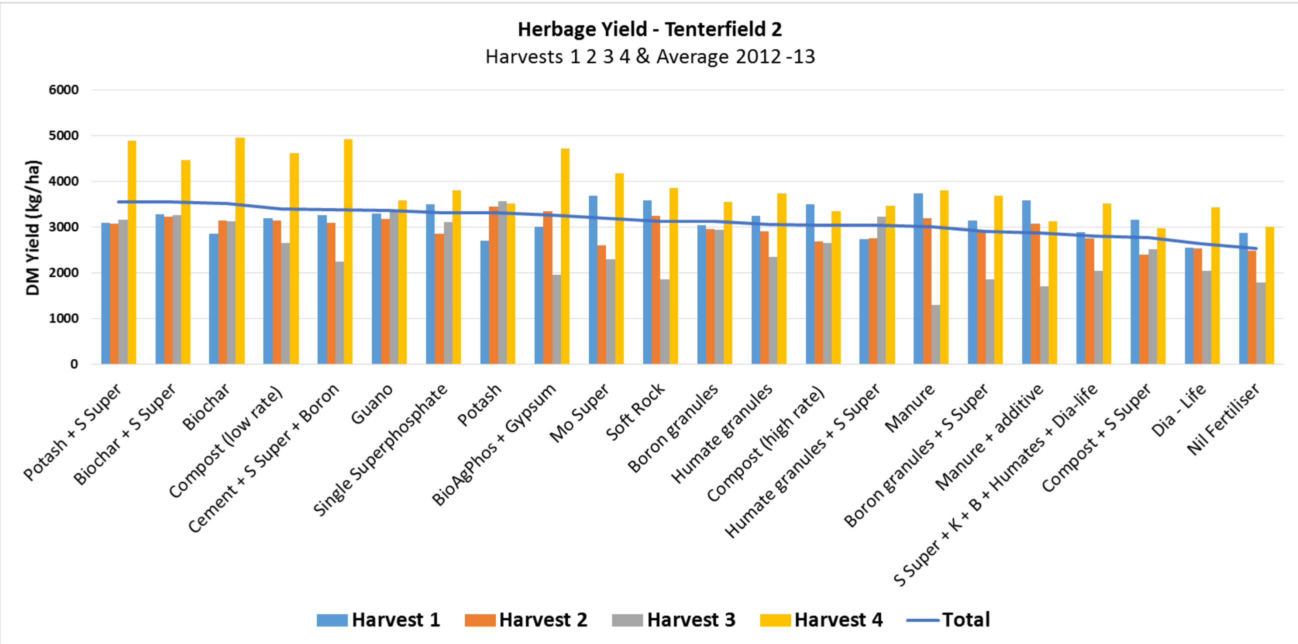

Figure 3.

Tenterfield site 2 – Herbage yields overall (average), harvests 1, 2 & 4 showed no significant differences between treatments, although there was a trend to applying nutrients. Harvest 3 did show significant differences to some treatments – see figure 4 below.

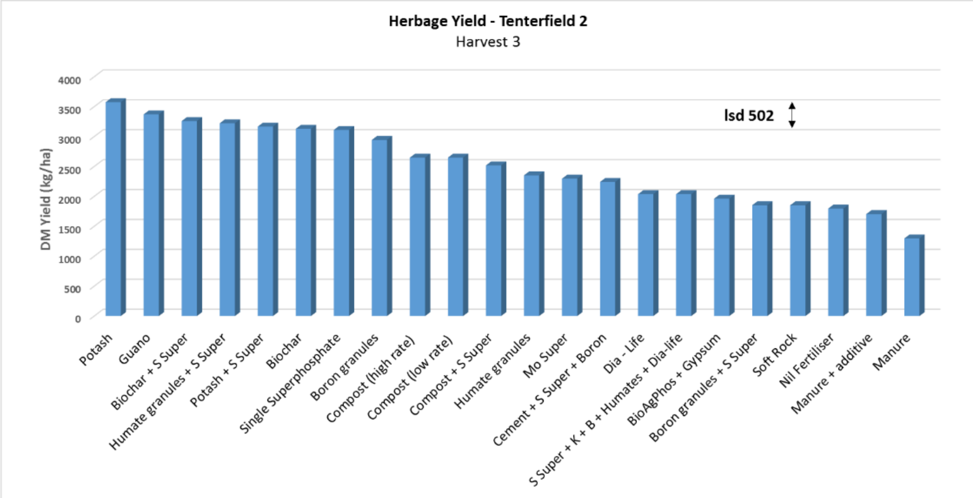

Figure 4.

Tenterfield site 2 – Harvest 3 shows a significant difference between potash, Guano, Biochar + S Super, Humate granules + S Super, Potash + S Super and S Super compared to the rest of the treatments.

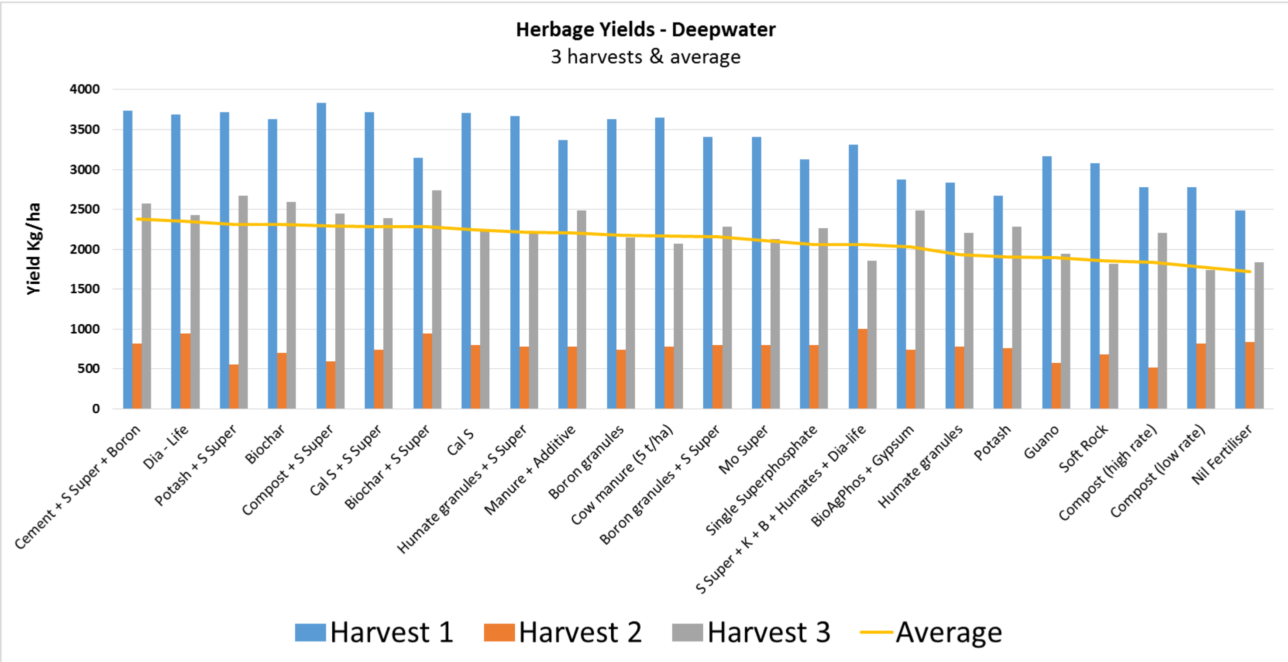

Figure 5.

Deepwater site – Herbage yields did not show any significant differences for harvest 1, 2 and overall (average). There was a significant difference appearing in harvest 3 – see figure 6 below.

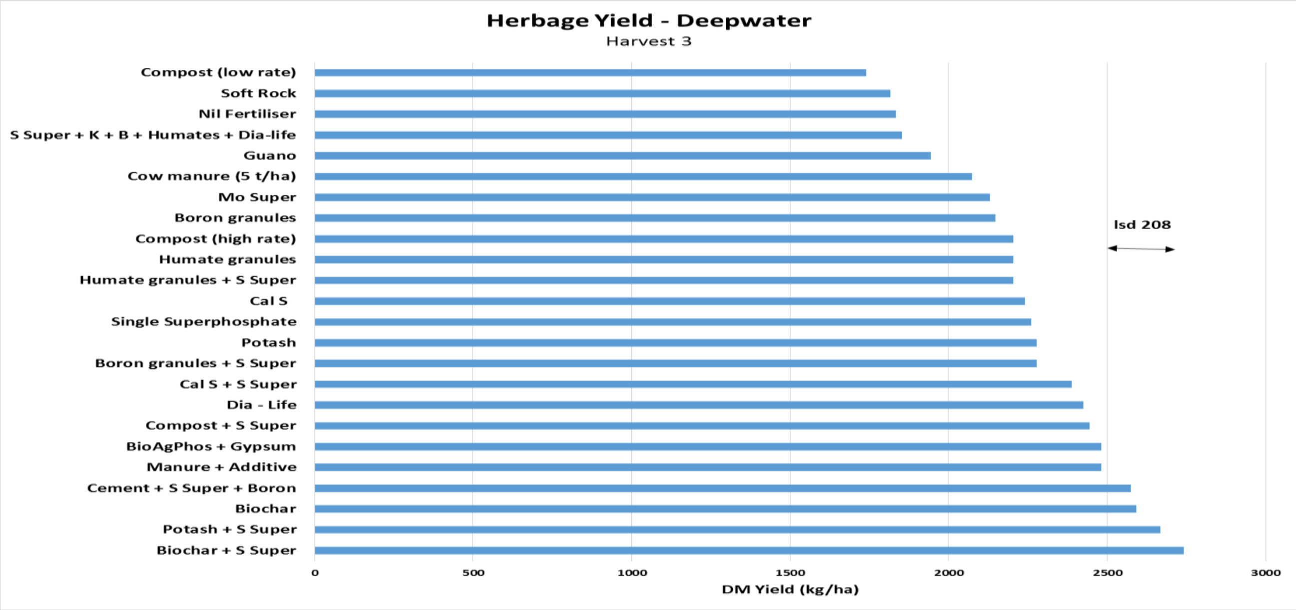

Figure 6.

Deepwater site – Herbage yields for harvest 3 showed significant differences for the treatments of Biochar + S Super, Potash + S Super, Biochar and Cement + S Super + Boron compared to the other treatments.

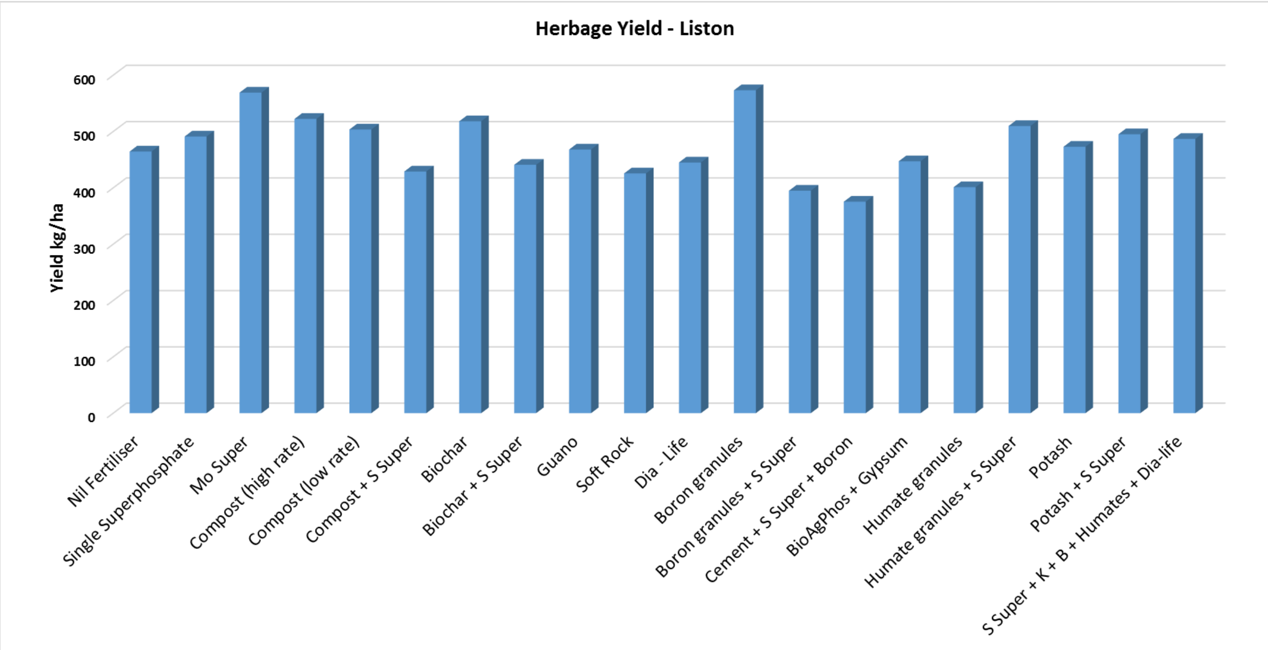

Figure 7.

Liston site – herbage yields showed no significant differences between treatments at P < 0.05 level.

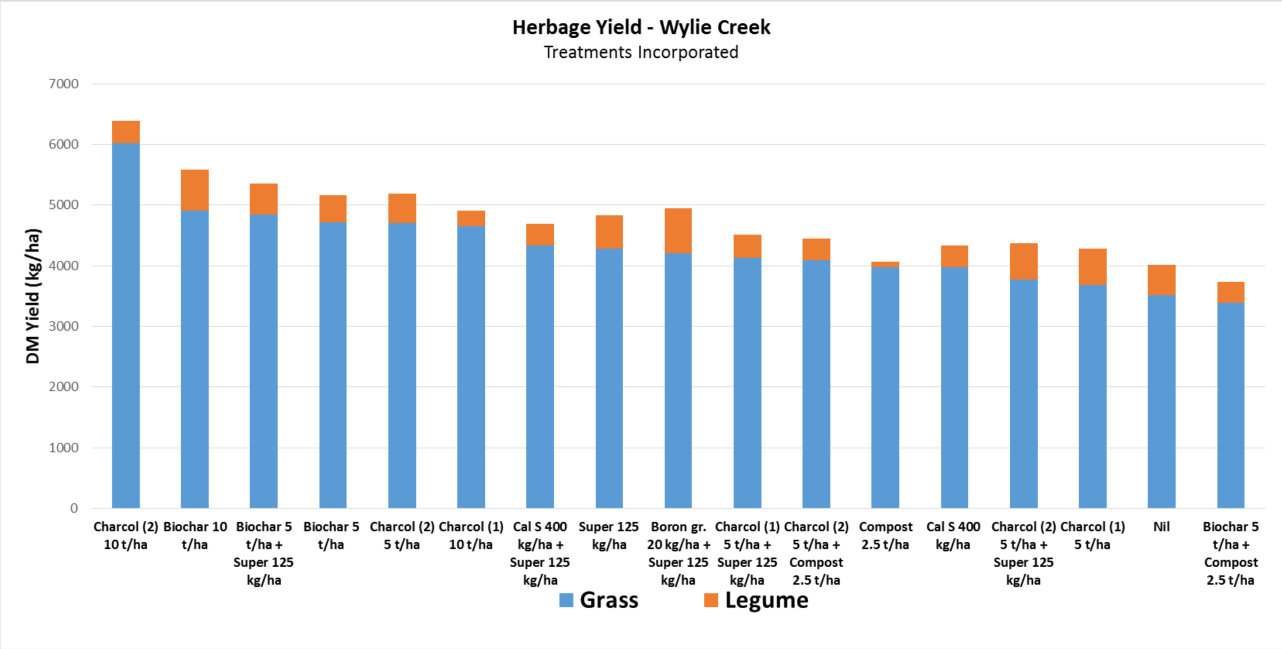

Figure 8.

Wylie Creek site (treatments incorporated) – herbage yields showed no significant differences between treatments at P < 0.05 level.

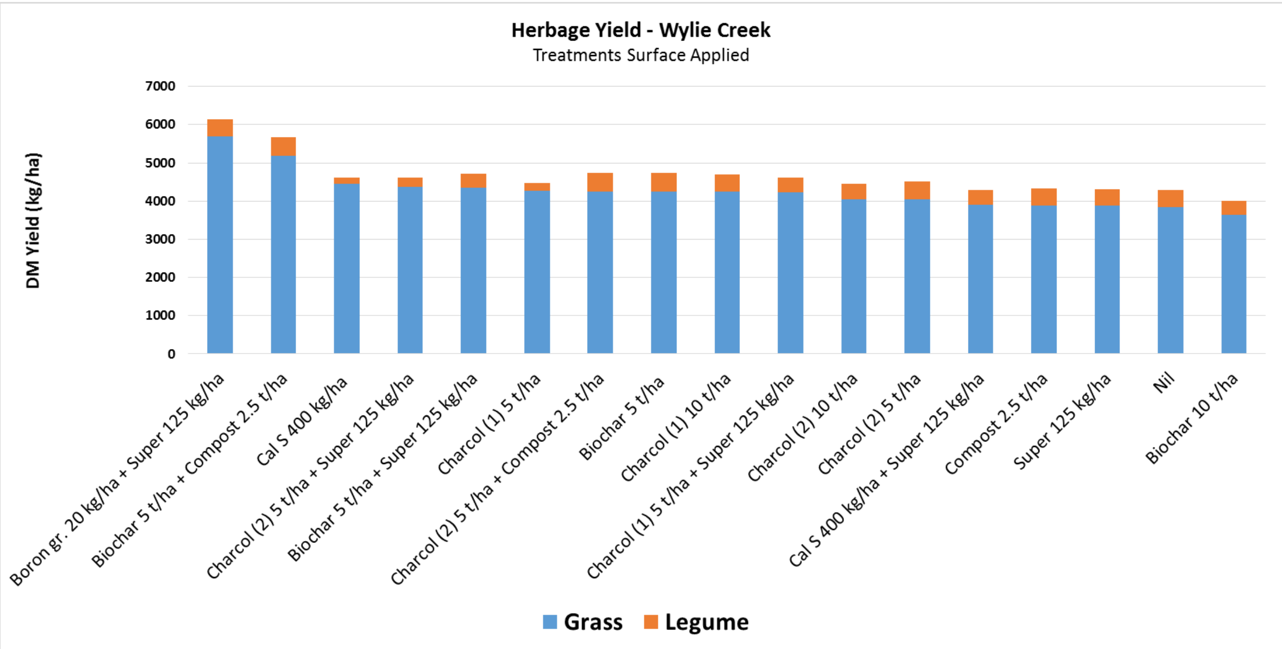

Figure 9.

Wylie Creek site (treatments surface applied) – herbage yields showed no significant differences between treatments at P < 0.05 level.

One of the better indicators to improved soil nutrition particularly with P & S is the amount of legume present in the pasture. A visual estimate of the content of clover in each treatment was undertaken over 3 sites. Clover content is greatly influenced by seasonal conditions, soil nutrition and grazing management. The highest clover content was found in the highest rainfall and fertiliser history site that is managed under the strategic grazing method. The results (figure 10) could not be statistically analysed, but visually there were no big differences between treatments. However there is an indication of a trend, showing a clover response to P, S, K, Mo & B. Local knowledge of the area would support this trend.

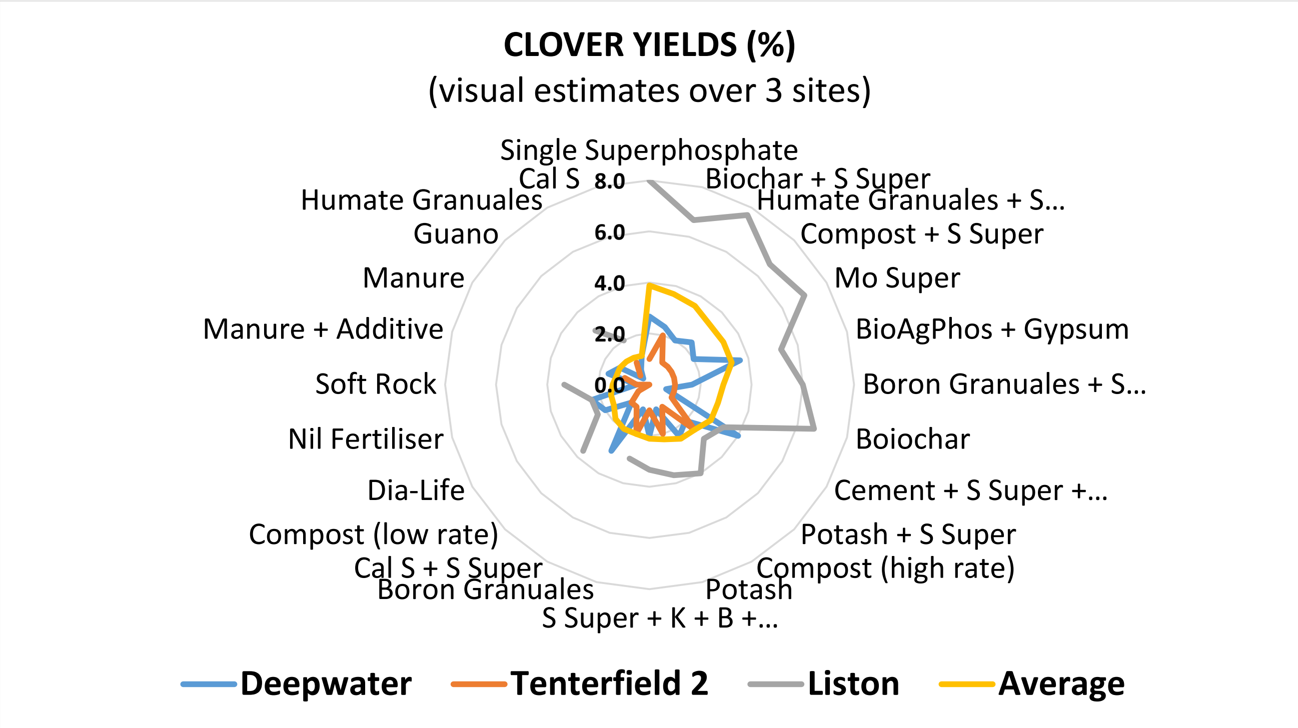

Figure 10.

Clover yield estimates – indication of trend showing a response to Phosphorus, Sulphur, Molybdenum and Boron from all sites. Biggest response occurred at the highest rainfall and fertiliser history site.

Soil nutrient levels were ascertained through soil testing (Incitec Pivot). An analysis could not be undertaken because of the bulking of replications. However there are certain trends that can be drawn from the data which is supported by local knowledge and previous independent trials done in the past.

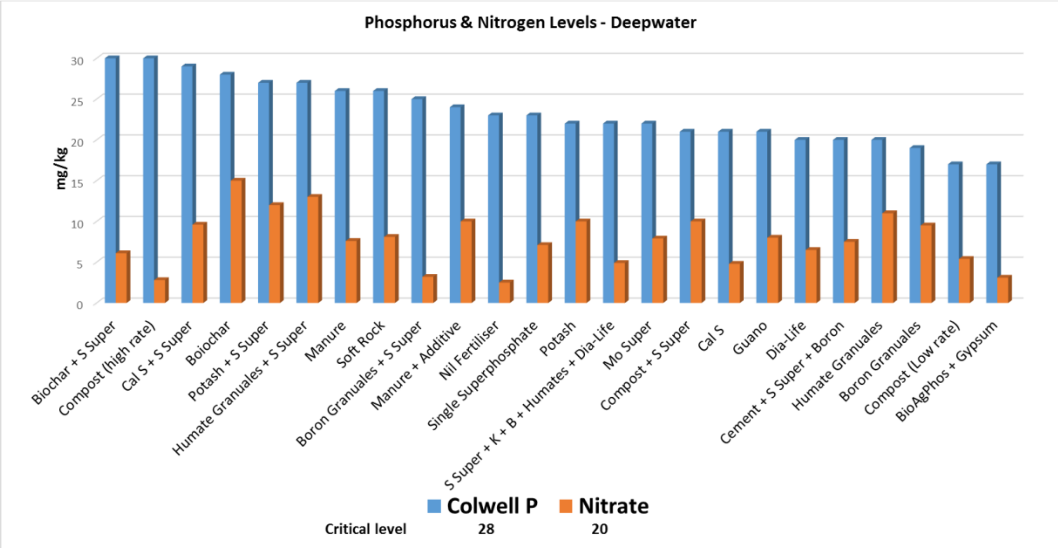

Figure 11.

Deepwater site – soil tests for phosphorus (P) indicated higher levels of P where the treatments contained an available form of P in the product. No such trend could be assumed with the nitrogen (nitrate) soil tests.

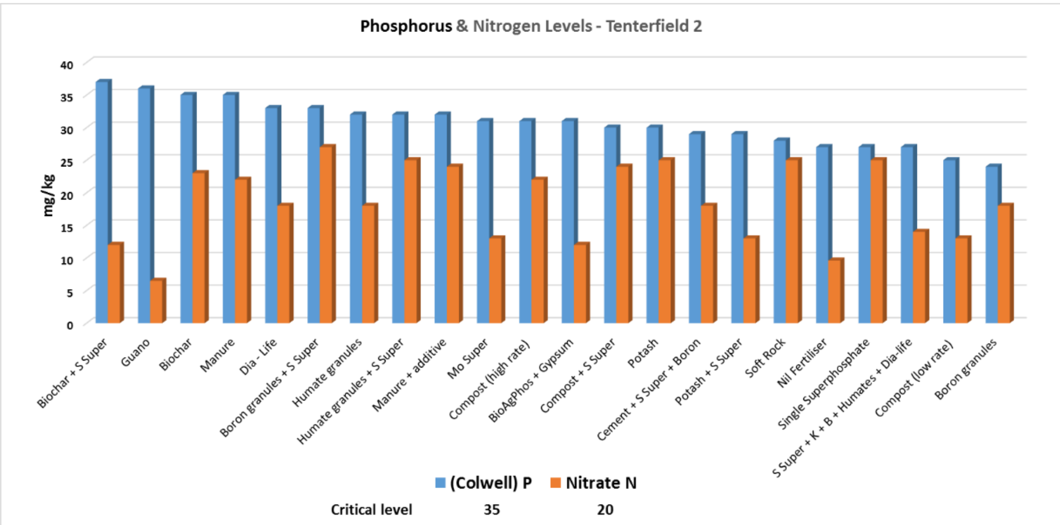

Figure 12.

Tenterfield 2 site – no great trend for phosphorus (P) presumably because the background levels of phosphorus were much higher compared to the Deepwater site.

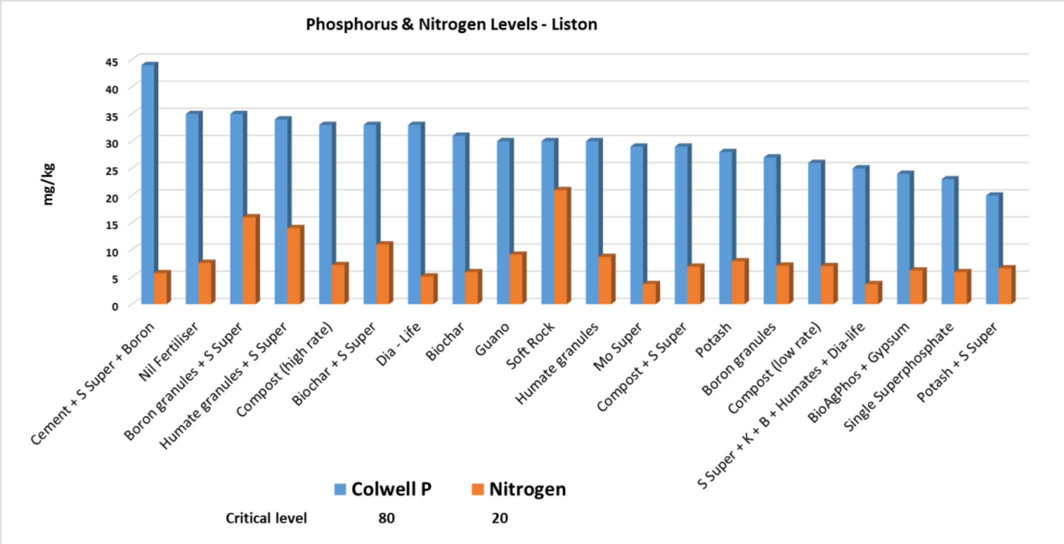

Figure 13.

Liston site phosphorus and nitrogen levels did not appear to follow any trends due to treatments.

Biochar (with or without single superphosphate) consistently ranked in the higher levels of P. Obviously this could be coincidental but it does indicate that more research maybe required. The data indicates a trend that those products with the highest levels of P usually resulted in the higher soil P levels. No trend could be pulled out regarding nitrogen levels. Clover presence did not seem to form a trend for indicating nitrogen levels. This may be due to the low levels of clover recorded.

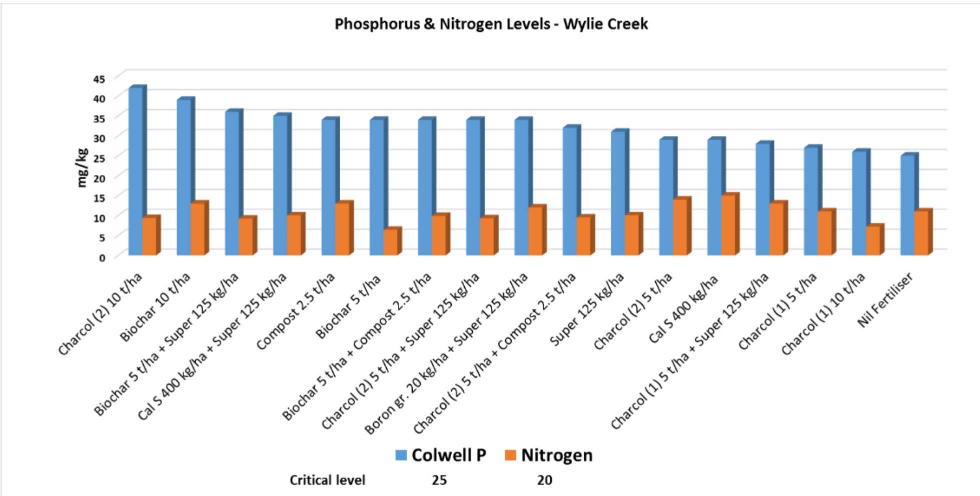

Figure 14.

Wylie Creek site showed a trend in increasing soil P levels by applying those treatments/products that contained P

Other soil nutrients levels did not reveal any useful information. Not unexpected is the boron (B) levels at all sites, which is below optimum. Even when boron was added in the treatments, it did not significantly raise soil levels (plant tissue testing is a better indicator).

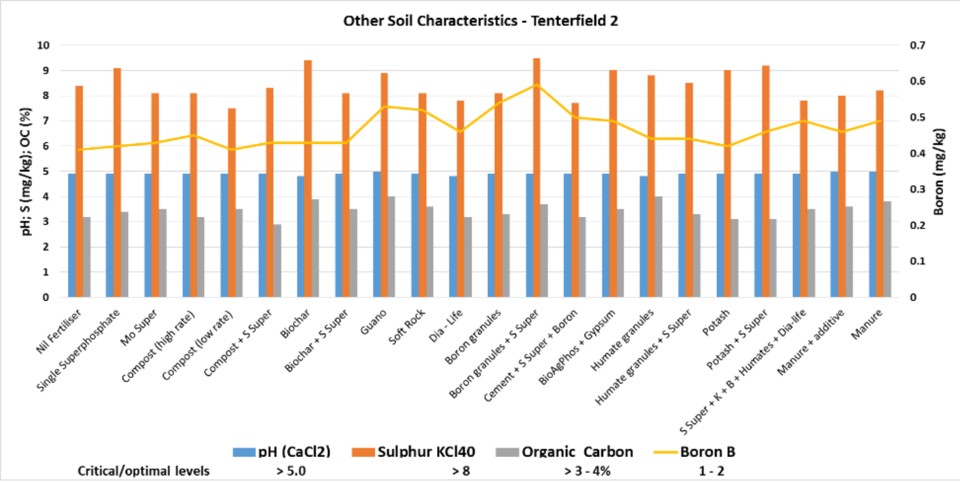

Figure 15.

Tenterfield 2 site – Boron levels well below optimal, with the other characteristics (pH, S, OC) falling within or close to the optimal range. Addition of Boron in the treatments did not increase soil levels.

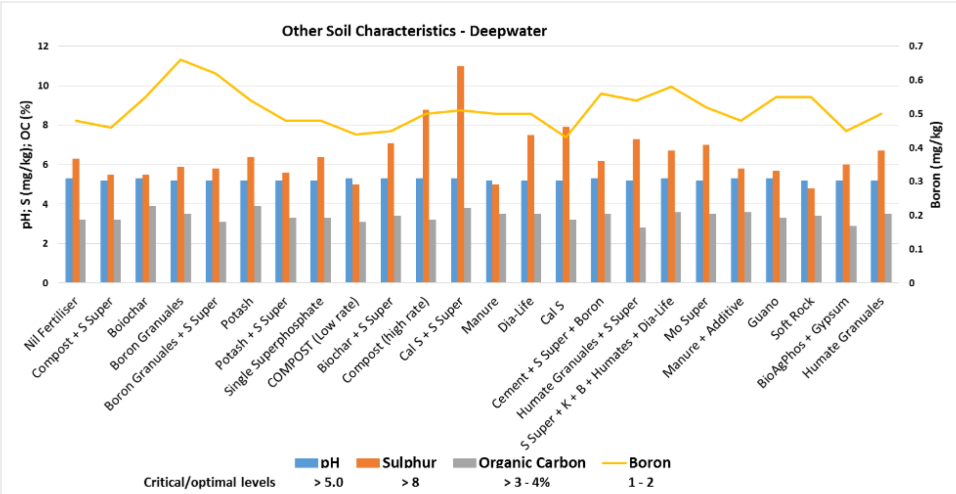

Figure 16.

Deepwater site – *Boron levels well below optimal, with the other characteristics (pH, S, OC) falling within or close to the optimal range. Addition of Boron in the treatments did not increase soil levels.*

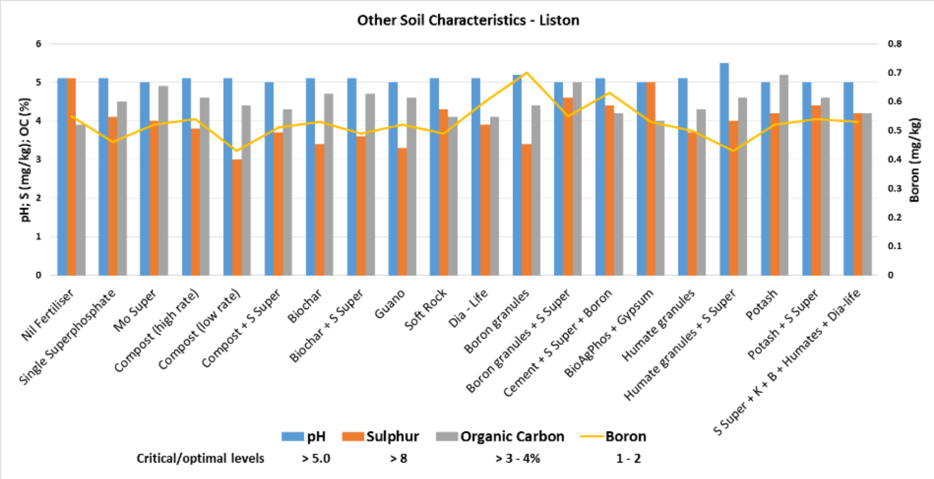

Figure 17.

Liston site – pH and organic carbon levels are above critical levels, but both sulphur and in particular boron levels are below optimal levels. Treatments did not appear to influence soil levels of the particular soil characteristics.

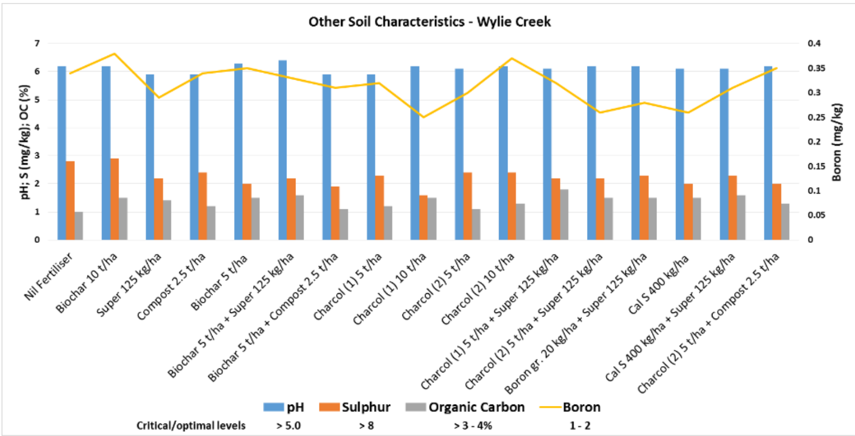

Figure 18.

Wylie Creek site – soil pH was within optimal levels, but sulphur, organic carbon and boron levels were below desired levels. Treatments did not appear to influence soil levels of the particular soil characteristics.

Soil biology was also investigated at 2 sites (Tenterfield 2 & Deepwater) to ascertain if any treatment had any effect on biological levels. Tests were for bacteria (total & active), fungi (total & active) and mycorrhizal colonization (figures 19, 20, 21, 22). Again it was not possible to detect significant differences between treatments but it is possible to detect trends. The treatments that had the highest P levels or organic matter were the treatments that tended to have the highest total bacteria and although not as strong in trending, active bacteria followed similar lines. The fungi levels both total and active did not appear to follow any trends with the different treatments.

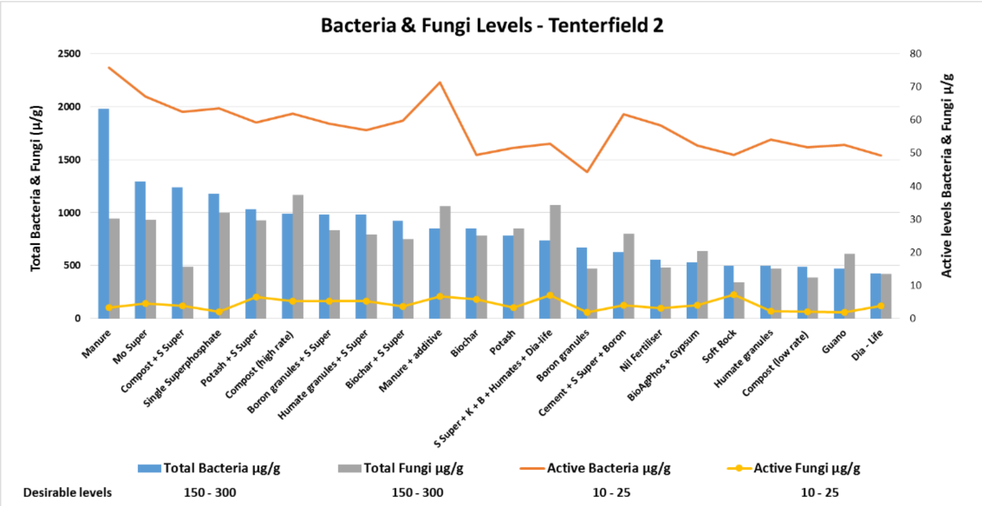

Figure 19.

Tenterfield site 2 – a trend appears to occur with an increase in bacteria and fungi levels in the treatments that contain phosphorus.

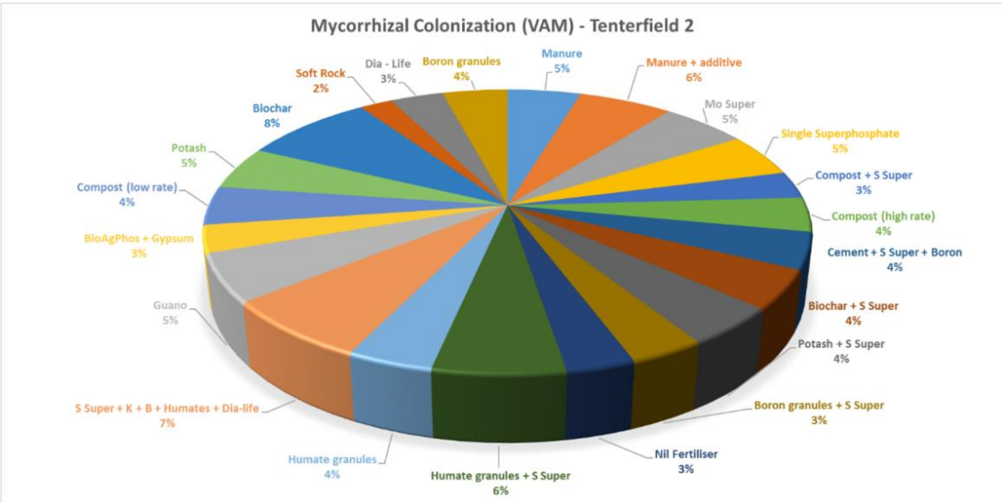

Figure 20.

Tenterfield site 2 – mycorrhizal levels tended to be higher in treatments that contained phosphorus.

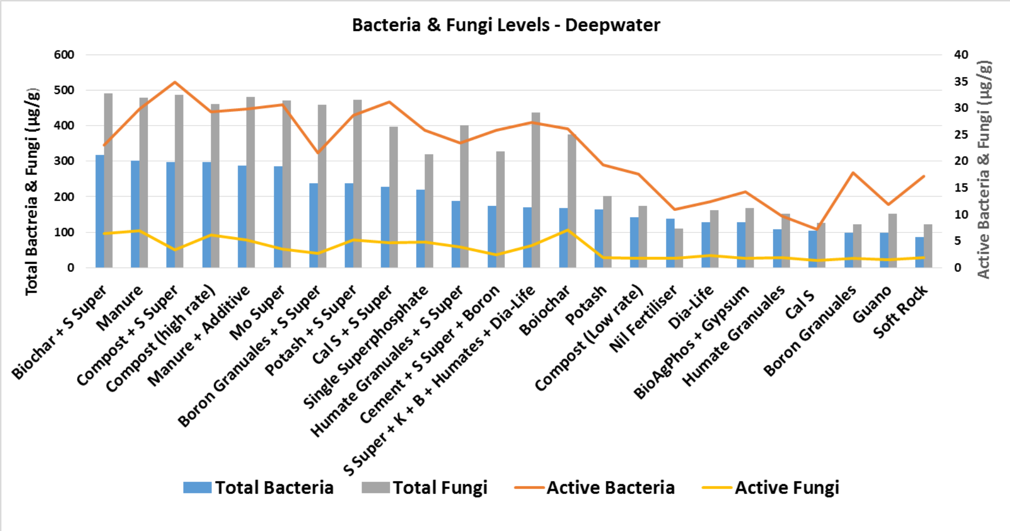

Figure 21.

Deepwater site – bacteria and fungi levels trended towards higher levels in treatments that contained phosphorus.

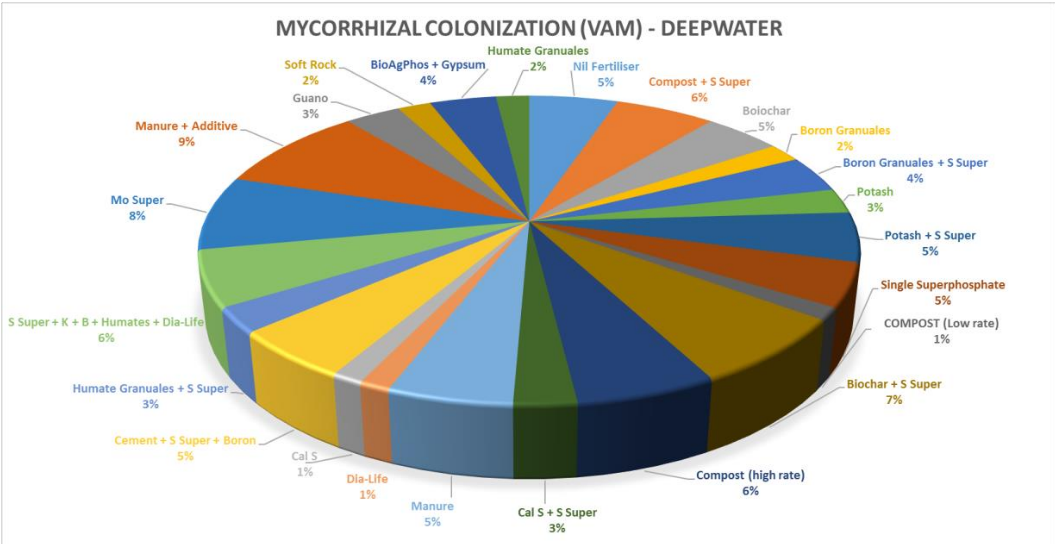

Figure 22.

Deepwater site – mycorrhizal levels tended to be higher in treatments that contained phosphorus.

Conclusion

The objectives may not have been met completely but the project has been highly beneficial to the local livestock producers with a number of messages being applicable to producers on a much wider basis. Trends and significant differences have generally occurred positively with the traditional fertiliser products, suggesting that producers need to continue with a regular fertiliser program. A producer comment at the last field day supported this in the statement “the best & fattest cattle in the saleyards usual comes from those blokes that regularly topdress with super” (Grant Johnston, Tenterfield).

The project has also highlighted the need to identify the nutrients that are most limiting and then select the most appropriate product taking account of the availability of the nutrients within the products. Although phosphorus (P), sulphur (S) and molybdenum (Mo) are generally the most

limiting nutrients on the Northern Tablelands soils, there is now a need to be mindful of other nutrients including both macro and micro nutrients. Potassium was identified at one site with a significant response recorded. Of the micro nutrients Boron tested below optimal levels at all sites. As one of the trial cooperators (Paul Donnelly, Tenterfield) commented - “I was happy with the trial but unfortunately a dry period hit not allowing for any results. But after rain I could see a response to trace elements. So from the trials I’ve learnt that I should be looking closer at trace elements”.
The economics should always be considered before embarking on a fertiliser program. Although this project wasn’t able to show significant differences between treatments and therefore not practical to calculate economics, the trends would indicate that the appropriate nutrients should be applied to maintain production. As one member (Rod Dowe, Tenterfield) of the group said “we need this type of work to continue to help us producers make the right decisions”. Another participant (James Meade, Warwick) at the last field day also made a pertinent comment in saying “great work as it gives me a clearer picture as to what I should be doing and will now use fertiliser on a more regular basis to maintain profitable production”.

Jeff Lowien presentation on trial at field day in Tenterfield NSW.

Take Home Messages

- There are no silver bullets or short cuts to fertiliser management in maintaining livestock production.
- Assess all factors involved in the livestock production system – soil chemical, physical (water infiltration, penetration etc.) & biological levels (calico strips, ground cover etc.), pasture (composition, types, growth etc.), grazing management, livestock management (parasites, health, regular weighing etc.), climate changes etc.
- Identify the nutrients that are most limiting and/or require maintaining for your enterprise stocking rate and then select the most appropriate product (taking account of the availability of nutrients within the products) to achieve this goal.
- Generally phosphorus, sulphur & molybdenum (occasionally selenium, cobalt & copper in livestock) are still the most limiting factors to livestock production.
- Always consider the economics – can you afford not to apply nutrients?