

Growth Response to the Application of Bush Tucker® Fertiliser in two Australian Native Plants



NEUTROG™



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Bush Tucker®. Neutrog Australia.

Abstract

In a trial using a new low-P fertilizer for native plants "Bush Tucker®" both a very P sensitive plant Grevillea Poorinda 'Royal Mantle' and a non-P sensitive plant Anigozanthos flavidus 'Landscape Violet' showed positive growth responses up to 3 kg/m³ of applied fertilizer. Plants at the 3 kg/m³ application rate had five times the above ground fresh weight for the Grevillea and 2.5 times higher for the Kangaroo Paw ($R^2 = 0.95$ and 0.80 respectively). The highly P sensitive Grevillea did not show P toxicity or foliar P levels in excess of 0.07 % P and the Kangaroo Paws showed foliar P within the normal range for the species (0.10% maximum). The Grevillea showed deficient foliar P levels at the control or zero rate of application.

It is concluded the fertilizer is safe for P sensitive native plants grown in poor soil at around 3-4 kg/m³ and for non-P sensitive plants at around 5-6 kg/m³.



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Introduction

Neutrog Australia Pty. Ltd. commissioned consultants Simon Leake and Angus Stewart to develop a fertilizer for Australian native plants with a wide range of P sensitivities using poultry manure as the base.

It is well known that the Proteacea including many Australian native plants show adverse reactions to phosphorus supplied in readily available form (Handreck 1991). Handreck (1997a) showed the phenomenon occurred not only in the Proteacea where most attention had been focused but also in the Fabaceae, Rutaceae and Mimosaceae amongst others. Handreck (1991) clearly linked the phenomenon to iron deficiency induced by excessive soluble phosphorus. Leake (2015) conducted experiments on growing a range of P non-P sensitive native species that suggested Manganese may also be affected by excessive phosphorus. Handreck (1997b) reviews the range of environments, physiological adaptations and occurrences of P induced toxicity in native plants.

Measurements of Neutrog raw material manures showed poultry manure can be high in soluble P but the sources vary. Accordingly a fertilizer was developed using one of the lower P sources of manure with the aim of further reducing P amount and solubility to mimic the low P formulations recommended for growing native plants. The aim was to make a fertilizer for the widest possible range of native plants that would supply enough P (since all plants need some P) but not in a soluble form known to harm P sensitive plants. The product has been named by Neutrog "Bush Tucker".

To validate the new product a trial was conducted using a very P sensitive plant *Grevillea Poorinda 'Royal Mantle' (GPRM)* and a non-P sensitive plant *Anigosanthos flavidus 'Landscape Lilac' (AFL)*. Plant growth responses were recorded using a low nutrient unimproved sandy Kandosol A horizon in pots dressed with the equivalent of 0, 1.0 and 3.0 kg/m³ of Bush Tucker® native plant fertilizer. The control rate was duplicated and the other two rates were triplicated. Pots 400mm high made of 200mm PVC stormwater pipe with geotextile fabric taped over the bottoms were filled with the treated soils and tubestock sized propagation material were planted into the soil medium. The trial was established on 17 September 2015.

Plants were watered normally in the environment of a production native plant nursery.



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The Bush Tucker® fertilizer

Stated analysis of the fertilizer is given in Table 1.

Analysis (dry weight basis)		%w/w
Nitrogen (N)	as Organic	1.00
	as Ammonium	9.00
Total Nitrogen (N)		10.00
Phosphorus (P)	as citrate soluble	0.30
	as citrate insoluble	0.40
Total Phosphorus (P)		0.7
Potassium (K)	as Organic	0.50
	as Sulphate	7.50
Total Potassium (K)		8.00
Calcium (Ca)	as Organic	1.20
Sulphur (S)	as Organic	0.20
	as Sulphate	12.80
Total Sulphur (s)		13
Iron (Fe)	as Organic	0.06
	as Sulphate	0.06
Total Iron (Fe)		0.12
Manganese (Mn)	as Organic	0.02
	as Sulphate	0.01
Total Manganese (Mn)		0.03
Magnesium (Mg)	as Organic	0.03
Zinc (Zn)	as Organic	0.02
Copper (Cu)	as Organic	0.006
Molybdenum (Mo)	as Organic	0.0004
Boron (B)	as Organic	0.0015

N:P ratio 14:1

Table 1. Label Fertiliser Statement Bush Tucker®

Results

The trial was harvested on 12 Feb 2016 after nearly 5 months of growth by taking comparative photos and harvesting and weighing all above-ground parts. A selection of mature leaf blades were composited within each treatment to form 3 samples of each species within treatment for plant foliage analysis. The analysis uses oxidizing acid and hydrogen peroxide digestion followed by ICP-OES analysis of all elements except Chloride which is analysed colourimetrically. All analysis was conducted by SESL Australia.

Photographic Records

Photos 1 and 2 show the general appearance of GPRM and AFLL respectively at the end of the trial.



Photo 1. Visual response of GPRM, Left to Right, Control, 1 kg/m³ and 3 kg/m³ of Bush Tucker

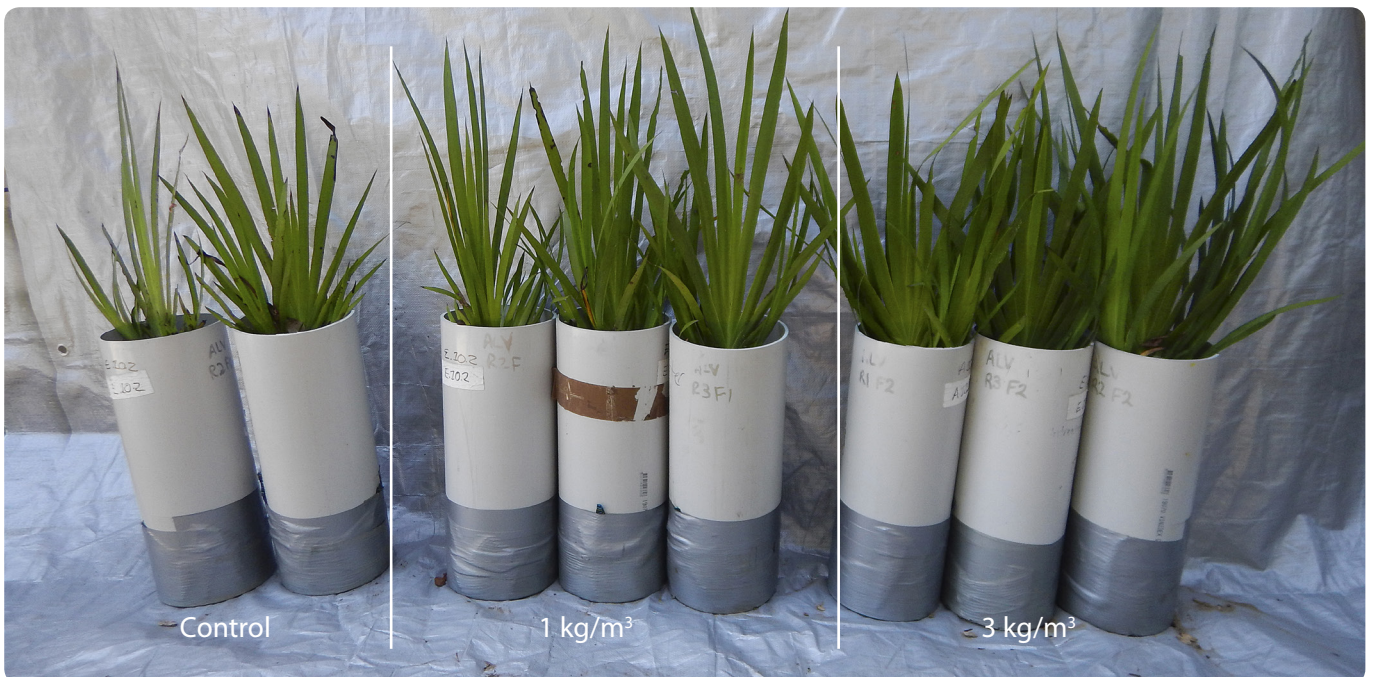


Photo 2. Visual response of AFLL, Left to Right, Control, 1 kg/m³ and 3 kg/m³ of Bush Tucker

Above ground yield

Harvesting revealed one Grevillea plant in the 3 kg/m³ treatment that was stunted due to borer and leaf eating insect attack. It was rejected as anomalous. The fresh weight of above ground parts data for GPRM is given in Figure 1 together with a third order polynomial regression curve, which gave the best regression fit.

Data for the AFLL is given as Figure 2. Again, a second order polynomial gave better regression coefficient than a linear regression line.

GPRM fresh wt vs rate

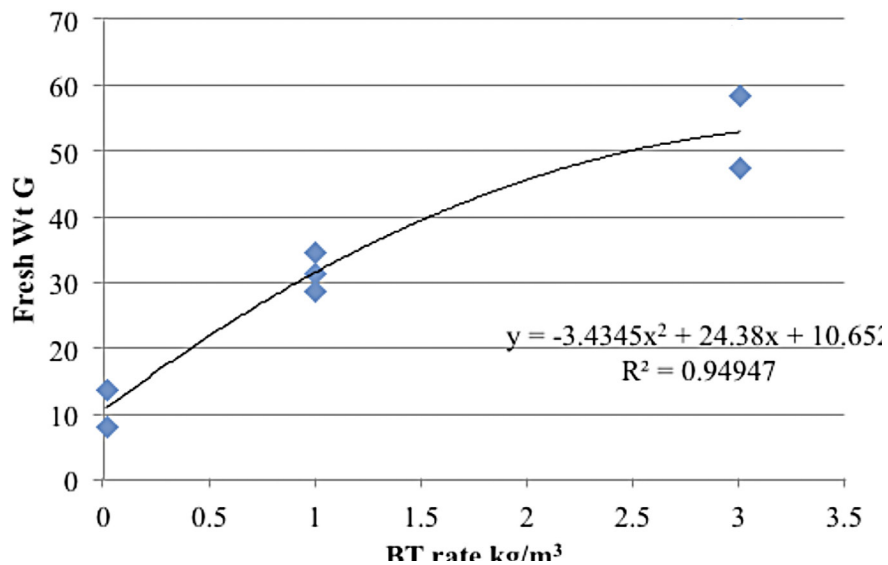


Figure 1. Growth response in GPRM.

AFLL fresh wt vs rate

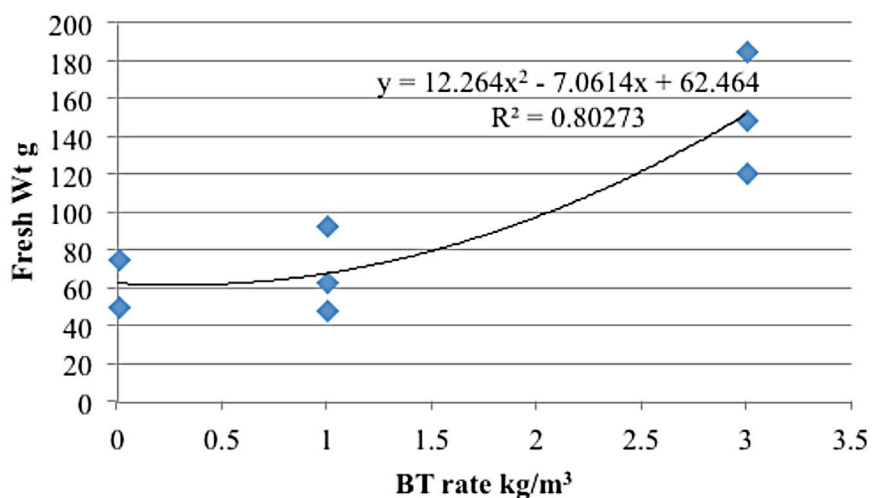


Figure 2. Growth response in AFLL.



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Plant Foliage Analysis

Results of composited mature leaf blade analysis of GPRM and AFLL are given in Tables 2 and 3.

Treatment	GPRM	GPRM	GPRM	"Normal" range*
Fertiliser Rate	Control	1 kg/m ³	3 kg/m ³	
N %	1.2	0.82	1.0	1.76
P %	0.04	0.05	0.07	0.09
K %	0.44	0.56	0.56	1.21
Ca%	0.31	0.39	0.39	0.81
Mg %	0.1	0.11	0.1	0.23
S %	0.08	0.08	0.09	
Fe mg/kg	58.7	56.1	46.7	
Mn mg/kg	180	259	220	
Zn mg/kg	25	31	33	
Cu mg/kg	2.4	2.4	1.7	
B mg/kg	9.8	8.6	8.9	
Cl mg/kg	0.24	0.39	0.12	
Na mg/kg	0.04	0.03	0.02	
NO ₃ mgN/kg	126	68.6	80.8	

Table 2. Leaf tissue analysis GPRM.

* Source: Cresswell and Weir (1997)

Treatment	AFLL	AFLL	AFLL	"Normal" range*
Fertiliser Rate	Control	1 kg/m ³	3 kg/m ³	
N %	0.96	1	1.6	1.0-1.7
P %	0.1	0.08	0.09	0.05-0.2
K %	2.33	2.37	2.51	1.4-2.0
Ca%	1.14	1.24	1.06	0.3-1.0
Mg %	0.31	0.31	0.22	0.1-0.3
S %	0.14	0.14	0.22	
Fe mg/kg	29.5	33.6	50.1	60-90
Mn mg/kg	239	273	278	40-150
Zn mg/kg	56	54	68	10-50
Cu mg/kg	3.7	2.7	2.4	2-10
B mg/kg	11.1	9	8.5	
Cl mg/kg	0.84	0.37	0.37	
Na mg/kg	0.27	0.25	0.22	
NO ₃ mgN/kg	29.4	48.7	123	

Table 3. Leaf tissue analysis AFLL.

Source: WA Dept Agriculture "Growing kangaroo paws in Western Australia.

Ranges are for Anigosanthos pulcherrimus.

<https://www.agric.wa.gov.au/nursery-cutflowers/growing-kangaroo-paws-western-australia?page=0%2C1>

Discussion

Both plants showed a strong positive growth response to the application of Bush Tucker® fertilizer. The response curve for the Grevillea is typical of a plant the yield of which is starting to flatten off typical of the “yield plateau” effect above which no further response might be seen. It is not unexpected to find that a plant with such low soil fertility requirements would show significant response to small amounts of fertiliser and a yield plateau at relatively low fertilizer application rates. The regression equation extrapolates the yield plateau (the maximum application rate) for this plant would be in the vicinity of 3-4 kg/m³ (300-400 g/m² if surface applied) for soil of very low fertility.

Figure 3 shows the relationship of foliar P to application rate. Even at the high application rate phosphorus is not at toxic levels. 0.12 % P might be considered to verge on toxic foliar P level for this species and, if the regression line holds true at higher rates then the application rate would need to be at 8 kg/m³ to cause this. Extrapolation of this kind is not reliable but the data suggests the P is in relatively low availability form and is balanced by much higher levels of other nutrients. Levels of P below 0.05% could be considered deficient for this species.

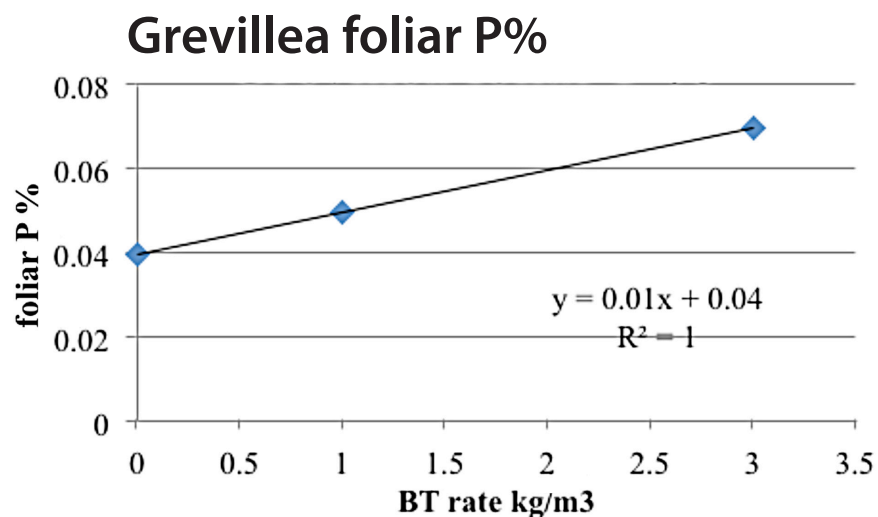


Figure 3. Foliar P levels in GPRM

Data for the other nutrients is much less clear with total N and NO₃ showing a possible inverse response to fertilizer application. This has to be interpreted carefully as it is known that deficiencies in P, for example, adversely effect N metabolism resulting in an accumulation of nitrate for example. Also, as the plant grew much larger some nutrients can fall behind or become “diluted”. This may be occurring with Fe.

The data appear low against the published normal range data for Grevillea Poorinda ‘Firebird’. The published data often represents nursery grown plants being fed for maximum growth rates and may not be indicative of field grown plants. Phosphorus levels are closest to those in the published normal range where <0.08% is suggested as deficient and 0.27% as excessive. The published data may have to be questioned for this species as growth at both rates of BT application appeared perfectly normal suggesting the plant is tolerant of lower nutrient levels than the published species. Handreck (pers. comm.) suggests anything above about 0.15 to 0.18 % for Grevilleas is excessive to their needs.

The AFLL shows a very different type of response than the Grevillea. Here, the plant is still showing an accelerating response at 3kg/m³ with no indication of having reached the yield plateau. This response is typical of plants with high nutrient requirements and response.

With the AFLL both total and NO₃ N show clear positive responses as seen in Figures 4 and 5. The total N content almost exactly parallels the growth rate response.

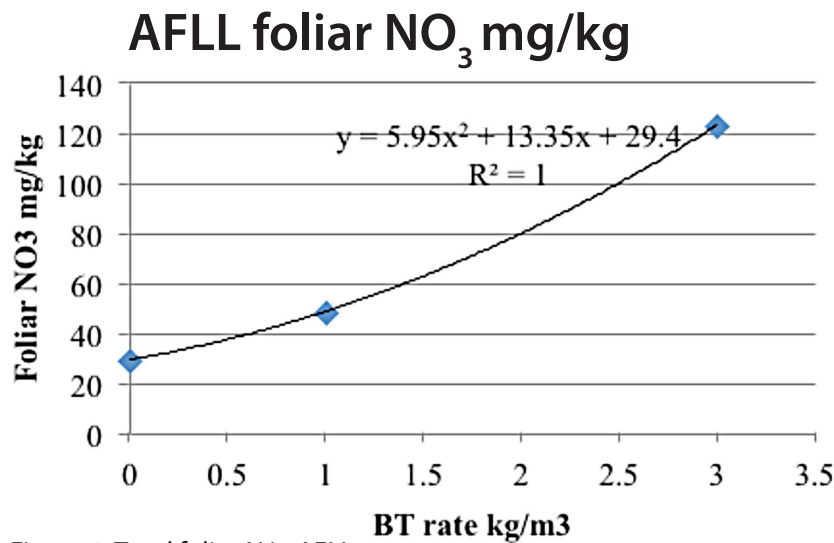


Figure 4. Total foliar N in AFLL.

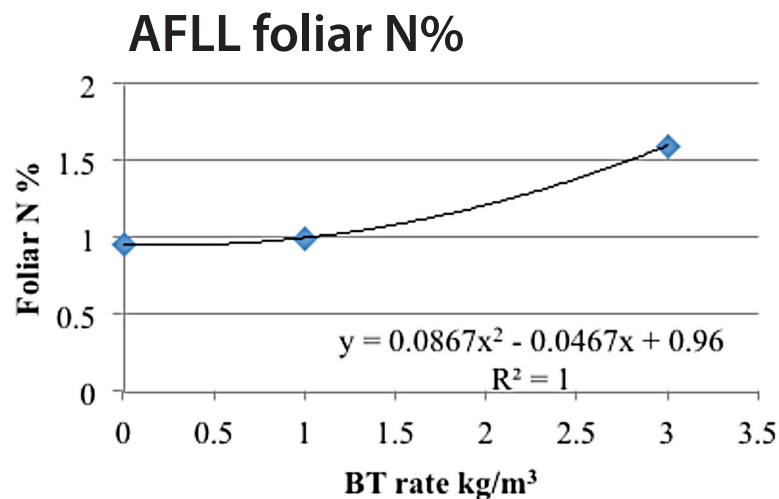


Figure 5. Foliar NO₃ levels in Anigozanthos hybrid.

Foliar P levels show no apparent response to the P added in the fertilizer. Even the Control rate shows apparently adequate P. However, based on greatly increased yield it can be concluded that at the highest fertiliser rate the plants withdrew 2.5 times as much P from the soil compared to the control.

The fact the N content of the leaf parallels the growth rate and the flat response to just about every other element supports the conclusion that N is in excess compared to the other elements in the soil. In other words it suggests N is not the limiting element for growth of Kangaroo Paw in this trial but that some other element, perhaps P, is the limiting factor. It cannot be potassium as the plant shows excess potassium even with no added fertilizer P. The fact that every other element than P is at or above the normal range and P is on the lower side of the normal range further supports a view the P level in the fertilizer could be higher for this species.

The only elements to actually decline are copper and boron suggesting the fertilizer is too low, compared to other elements, in these elements.

The only other element to show a clear increase with fertilizer rate is iron suggesting the fertilizer contains excessive iron compared to other elements.

Conclusions

At the rates used both a P sensitive and a P tolerant native plant showed strong positive responses to the fertilizer Bush Tucker up to 3 kg/m³ rate of incorporation into a poor sandy soil. The P sensitive plant did not show P levels anywhere near those associated with toxicity and the non-P sensitive plant showed levels within the expected normal range for the genus. Indications from the trial are that the non-P-sensitive plant would have likely responded to and tolerated application rates higher than the maximum 3kg/m³ used but that this represents close to the maximum the P sensitive plant would have responded to.

Overall the fertilizer appears to have a reasonable level of P, in suitably low solubility form, to provide close to optimal nutrition for a wide range of P tolerance, enough for the non-P sensitive species a but not too much for the highly P sensitive species.

The data suggests application rates to very poor soils should be in the range of 300-600 g/m², depending on P sensitivity (assuming a zone of influence of to 100mm depth) for new plantings in poor sandy soils that have not been previously improved. For soils where P levels are already elevated these rates should likely be decreased.

The data suggests the fertilizer could be supplemented with copper and boron to address what appears to be a deficiency in these elements.

References

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22 March 2016.

