The value of 'alternative' nitrogen fertiliser products on pasture. 1. Pasture production at three sites

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Abstract: *A series of experiments at Tocal, Taree and Berry on the NSW coast from winter 2009 to summer 2011compared the production of pastures topdressed with a range of coated urea products, alternative fertilisers and growth stimulants. Dry matter harvests were taken at a 3 to 8 week intervals depending on the growth rates of the dominant pasture type (kikuyu pasture from December to March and ryegrass pasture from June to November). Only treatments receiving at least 23 kg nitrogen (N)/ha from urea based products, significantly (P <0.05) increased pasture production over the control at every harvest. The greatest production responses were from urea products applied at 46 kg N/ha after each harvest at Berry and Tocal and 100 kg N/ha applied at every second harvest at Taree.*

Key words: pasture, topdress, dairy, alternative fertiliser, poultry litter, Urea, Green Urea, Entec Urea, Twin N, Urea Supreme, Nutrisoil, ProGibb, Liquid Blood & Bone, dry matter

Introduction

Since 2007 increasing fertiliser costs have heightened farmer interest in 'alternative' fertiliser products aimed at reducing nitrogen (N) costs in pasture grazing systems. These include a range of biological sprays, compost extracts, fish emulsions, vermiculture liquids, hormonal granules, and composted mineral blends that may play a role alongside, or instead of, more 'conventional' products such as urea amendments and growth promotants

Urea applied at 30–50 kg N/ha/grazing, (150–500 kg N/ha/yr), is the most common form of N application for coastal pastures. Urea is subject to losses from volatilisation, nitrate leaching and denitrification that increase pasture production costs and pose an environmental threat. The magnitude of losses is highly dependent on the rate and method of application, soil characteristics, soil moisture and weather conditions at the time of application (Trenkle 2010; Watson *et al.* 2009). Therefore losses are episodic, varying between seasons and years.

The currently available amendments to reduce N losses have three modes of action; urease inhibition, nitrification inhibition and slowed release of N via fertiliser coating. Highest benefits are recorded in annual crops where N application rates of 100–200 kg N/ha are applied as a single application at establishment (Trenkle 2010; Watson *et al.* 2009). Authors differ in their assessment of these amendments in pastures where lower rates (30–50 kg N/ha/grazing) are made over multiple applications that more closely approximate plant demand. For example, though some authors document positive yield responses to urease inhibitors (Watson *et al.* 2009), others report marginal, uneconomic responses (Stafford *et al.* 2008).

This paper presents results of a series of replicated plot trials conducted on the NSW coast and discusses the relative merit of the various alternative and conventional products tested as potential sources of N for pasture production.

Methods

A series of three randomised block plot trials, (four replications) were established during 2009. The sites were highly fertile commercially managed pastures, on the NSW coastal zone. The pastures, located at Berry, Tocal and Taree, were primarily composed of kikuyu (*Pennisetum clandestinum*) in the warmer months and oversown ryegrass (*Lolium spp.*) in the cooler months. Each trial comprised of between twelve and nineteen fertiliser treatments (including single or multiple untreated controls). Three sites were harvested using quadrates or lawn mower every three to eight weeks depending on the species, season and grazing rotation of the farm. Fertiliser was reapplied within 24–96 hours after each harvest.

Common treatments across all trials included, hand broadcast urea, and urea amendments: Green Urea™ a urease inhibitor, Entec Urea™ a nitrification inhibitor, and Urea Supreme™ a polymer coated urea. Progibb™ a gibberellic acid, Twin N™ a non-symbiotic N fixation product were applied by boomspray application. Four liquid fertiliser products Nutrisoil™ and Liquid Blood and Bone™, at Berry, and TNN liquids (15:5:5) and organic (NK) at Tocal, were also applied by boomspray. Data collection was completed by autumn 2011.

Results and discussion

Berry

Regardless of coating, concentrated granular urea products had the most significant (P <0.05) effect on increasing dry matter production (Figure 1). Urea products applied at 100 kg/ha after each harvest grew 80–86% more dry matter than the control, while treatments incorporating 50 kg/ha of urea products grew 51–57% more. Poultry litter only produced significant (P <0.05) yield increases within three months of application. ProGibb applied alone did not have significant (P >0.05) effects on dry matter production for either total dry matter over the trial nor at any individual harvest. When Progibb was applied to plots treated with urea it did not increase yield over urea applied alone (Figure 1). ProGibb is marketed to be used in winter in cooler environments so the relatively mild coastal climate may have negated the benefits of gibberellic acid that have been observed elsewhere (Mathew et al. 2009). All treatments without urea produced no significant (P >0.05) dry matter production responses when compared with the control (Figure 1).

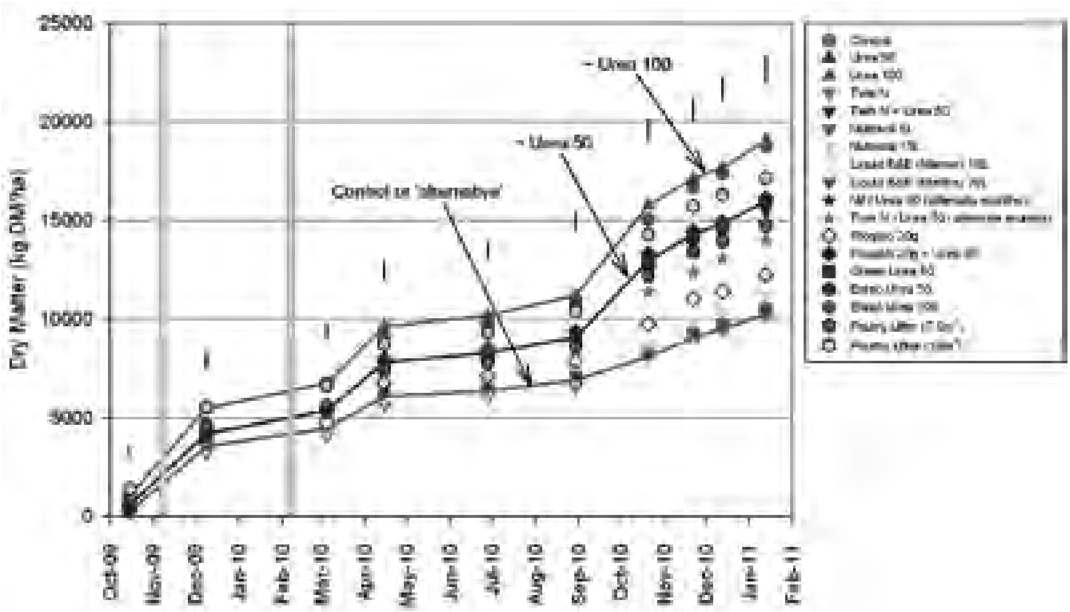

Figure 1. Effect of topdressed fertiliser treatment on cumulative dry matter production on a dairy pasture at Berry, NSW. Hatched areas in November 2009 and February 2010 indicate missed harvests. Vertical bars above treatment symbols represent the l.s.d. (P = 0.05).

The Nil/Urea 50 (alternate months) treatment produced the largest dry matter yield response per kilogram of applied N, achieving an extra 39.8 kg DM/kg N, followed by the Twin N/ Urea 50 (alternate months) treatment at 32.2 kg DM/kg N. Considering the costs of application, the Nil/Urea 50 (alternate months) treatment produced the largest dry matter yield response per dollar of applied product, with each extra kg of DM costing 6.2 cents, followed by the Urea 50 treatment at 9.5 cents. The Twin N/ Urea 50 (alternate months) was considerably more expensive at 14.5 cents for each extra kg DM. None of the non-urea fertiliser treatments produced a significant (P <0.05) yield response and hence were uneconomical.

Tocal

The dry matter production response to granular urea was similar at this site to that at Berry (data not presented). At each harvest during the ryegrass phase in 2009 there was a significant (P <0.05) response when at least 50 kg/ha of urea was applied. Responses to urea in the 2010 ryegrass phase were also significant (P <0.05), but patchy establishment lead to greater variation in the results. During the kikuyu phase over summer 2009–10 the response was less obvious, but still significant (P <0.05), with longer harvest intervals and increased N mineralisation attributed to the smaller treatment differences.

Taree

Applying at least 50 kg N/ha, regardless of the form, significantly (P <0.05) increased dry matter production of kikuyu (Table 1). However, there was significantly (P <0.05) lower response to poultry manure pellets supplying 50 kg N/ha compared with treatments containing urea at an equivalent N rate. This may indicate either lower N content in this batch of product than the bulk test, or a slower release of N from some fractions in the pelletised manure. Urea Supreme and Twin N + urea did not increase dry matter over that produced by urea alone with equivalent rates of N. Urea coatings and timing of application either before or after grazing had no additional effect on dry matter production (Table 1).

Table 1. Effect of topdressing treatment on the growth of kikuyu pasture at Taree, NSW in summer 2009–10. Those treatments not stated as 'before' (treatment applied two days prior to harvest) or 'after' (treatment applied after harvest), were topdressed after harvest. Treatments were applied at every second harvest.

	Treatment	Product rate (kg/ha)	Nitrogen rate (kg N/ha)	Total dry matter (5 harvests) (kg DM/ha)
1	Control-1	0	0	2916
2	Control-2	0	0	3003
3	Urea, High (Before)	217	100	6523
4	Urea (After)	217	100	7258
5	Green Urea (Before)	217	100	7230
6	Green Urea (After)	217	100	6909
7	Entec Urea	217	100	6812
8	TNN Urea Supreme	217	100	6972
9	Urea, Low	109	50	5530
10	Twin N + Urea, Low	109	50	5076
11	Twin N + Poultry Manure	1667	50	4129
12	Poultry Manure	1667	50	4185
			l.s.d. (P = 0.05)	706

Ryegrass dry matter production was significantly increased (P <0.05) by all forms of urea application (Table 2) regardless of the amendment coating or application rate used. The lack of a response between the 'high' and 'low' urea rate indicates the high rate was above optimum for this site. Therefore any reduction in N loss due to the amendments (applied only at the high rate) were not realised in the dry matter response. Gibberellic acid (ProGibb) and Twin N had no significant (P >0.05) effects on pasture production, consistent with results presented earlier in this paper.

Table 2. Effect of topdressing treatment on dry matter production of ryegrass at Taree, NSW in 2010. Treatments were applied after each harvest.

	Treatment	Product rate (kg/ha)	Nitrogen rate (kg N/ha)	Total dry matter (6 harvests) (kg DM/ha)
1	Control	0	0	5970
2	Urea, Low	109	50	10635
3	Urea, High	163	75	11540
4	Green Urea	163	75	11331
5	Entec Urea	163	75	10988
6	TNN Urea Supreme	163	75	11303
7	Black Urea	163	75	11378
8	Progibb 20g	-	0	6373
9	Progibb 20g + Urea, Low	109	50	10448
10	Progibb 20g + Urea, High	163	75	11398
11	Twin N	-	0	6331
12	Twin N + Urea, Low	109	50	10701
			l.s.d. (P = 0.05)	963

Conclusions

Our results indicated no production benefit from using any of the range of alternative fertiliser products, growth promotants and soil amendments that we used on intensively managed, high fertility, coastal pastures. In contrast, urea-based products provided a consistent N rate related response in all trials. This suggested the non urea-based products were unable to meet the plant demand for N or produce some other growth stimulation effect.

Amendments to reduce losses from urea showed no production benefit at application rates of 23–100 kg N/ha/cut. This suggested that in these pasture systems the probability of N losses is low when applied after each grazing, at normal commercial rates.

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References

Mathew C, Hofmann WA, Osborne MA (2009) Pasture response to gibberelins: a review and recommendations. *New Zealand Journal of Agricultural Research* **52**, 213–225.

Stafford A, Catto W, Morton J (2008) Ballance agri-nutrients approach to sustainable fertiliser use. In 'Proceedings: Carbon and nutrient management in agriculture'. (Eds Currie LD, Yates LJ). pp. 197–205. Occasional Report 21. (Fertilizer and Lime Research Centre, Massey University, Palmerston North, NZ)

Trenkel ME (2010) Slow- and controlled-release and stabilised fertilisers: an option for enhancing nutrient use efficiency in agriculture. Second Ed (IFA Paris, France). Available at: www.fertilizer.org.

Watson CJ, Laughlin R J, McGeough KL (2009) Modification of nitrogen fertilisers using inhibitors: opportunities and potentials for improving nitrogen use efficiency, *IFS Proceedings* **658**,1–40.