Guinto, D.F., Stafford, A., Blennerhassett, J. and Catto, W., 2018. Dry matter yield response of pasture to enhanced efficiency nitrogen fertilisers. In: *Farm environmental planning – Science, policy and practice*. (Eds L. D. Currie and C. L. Christensen). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 31. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 5 pages.

DRY MATTER YIELD RESPONSE OF PASTURE TO ENHANCED EFFICIENCY NITROGEN FERTILISERS

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Abstract

Field trials were conducted during winter to spring/early summer 2016 at three sites in the North Island (Hawke's Bay, Rotorua and Northland) to compare the performance of soluble N fertiliser (SustaiN), polymer-coated urea, methylene urea, and combination of SustaiN and polymer-coated urea (30%:70% mix) on pasture dry matter yield. All treatments were applied at an equivalent rate of 100 kg N/ha and applied only once except for SustaiN which was applied in three equal splits to mimic farmers' practice. Polymer-coated urea and the 30% SustaiN:70% polymer coated urea mix gave comparable dry matter yields as the SustaiN treatment. On the other hand, methylene urea generally produced lower dry matter yield than all the other treatments. While a single application of a slow release or controlled release N fertiliser to pasture represents a reduction in labour/application cost, this benefit will have to be weighed against its significantly higher cost per tonne relative to soluble N fertiliser like urea or SustaiN.

Introduction

Enhanced efficiency fertilisers (EEFs) are designed to reduce specific nitrogen (N) loss pathways. For example, urease inhibitors slow urea hydrolysis and target ammonia volatilisation. Controlled-release N fertilisers are typically coated or encapsulated with inorganic or organic materials that regulate the rate, pattern, and duration of N release. Slow-release N fertilisers involve a slower release rate of N than conventional water-soluble N fertilisers but the rate, pattern, and duration of release are not controlled because they depend on microorganisms whose effectiveness is dependent on soil temperature and moisture conditions. Slow or controlled release N fertilisers delay the release of N from the granules and they can potentially supply N at a rate that matches plant demand and reduce the risks of N loss. Thus, there is potential for these N fertilisers to increase dry matter yield relative to soluble urea and increase plant N use efficiency. Also, a one-time application of a slow release N fertiliser to pasture during late autumn/early winter will represent a saving on labour/application cost. However, research on the impact of the N "conserved" on pasture dry matter (DM) yield is variable (Dawar et al., 2011; Zaman et al., 2009). Therefore, in order to assess the yield benefit from the "conserved" N, field trials need to apply N over a range of rates to include those where N is applied below and at the level required for optimal growth; and across seasons to include periods when losses through the different pathways are high (Suter et al. 2015; 2016). The objective of this report is to compare the performance of a soluble N fertiliser (SustaiN, a urea fertiliser treated with Agrotain urease inhibitor) with StrategeN controlled release fertiliser (with and without SustaiN) and a slow release N fertiliser (Product 1, a methylene urea) at equal N rates.

Methods

Field trials were conducted during winter to spring/early summer 2016 at three sites in the North Island (Hawke's Bay [drystock], Rotorua [dairy] and Northland [dairy]) initially to compare the performance of two rates (30 and 100 kg N/ha) of soluble N fertiliser (SustaiN), two EEF N fertilisers (polymer-coated urea and methylene urea), and combination of SustaiN and polymer-coated urea (30%:70% mix) on pasture dry matter yield. In this paper, however, we report only results from the comparison of the 100 kg N/ha rates. All treatments were applied at an equivalent rate of 100 kg N/ha and applied only once at trial initiation except for SustaiN which was applied in three equal splits (at trial initiation and after the first and second cuts) to mimic farmers' practice. Experimental design was in randomised blocks with 5 treatments and 10 replicates (Table 1). Six DM cuts were made every 3-4 weeks during the growing period and total DM yield was computed. The Hawke's Bay site had become very dry after the fourth cut so no further dry matter data were collected (Total rainfall of only 356 mm from May to December). Initial soil chemical properties (0-7.5 cm depth) were analysed. These include pH, Olsen P, quick test cations and sulphate-S. Soil temperature (at 10 cm depth) was measured during each harvest date. For each site, analysis of variance was performed on each DM cut and the total DM yield. When significant differences between treatments occur, means were separated using Least Significant Difference (LSD) procedure at P=0.05. Coefficients of variation (cv's) were computed for each cut and the total DM yield. For each fertiliser treatment, percentage total DM yield increase relative to the control was also presented.

Table 1. Enhanced efficiency N fertiliser treatments used in the trials.

Treatment Description
1. Control
2. *SustaiN @ 100 kg N/ha
3. StrategeN @ 100 kg N/ha (Note: StrategeN is also known as SmartFert)
4. 30% SustaiN+70% StrategeN mix @100 kg N/ha
5. Product 1 @100 kg N/ha

*All treatments applied once only except for Treatment 2 which was split-applied 3X in equal doses to mimic farmers' practice.

Results and Discussion

Initial soil characteristics

Table 2 shows the initial chemical properties of the soils of the trial sites. With reference to dairy soil test categories set out in Roberts and Morton (2009), pH values are above the optimum for pasture (5.8-6.0) except for the Hawke's Bay site. Olsen P values were generally within the optimum levels. Quick test cation levels and sulphate levels were also good except for the Northland site with sulphate-S below 10 mg/kg.

Table 2. Initial soil chemical properties (0-7.5 cm) at the three trial sites.

Site	**pH**	**Olsen P (mg/L)**	**K**	**Ca**	**Mg**	**Na**	**SO_4-S (mg/kg)**
			(Quick Test, mg/kg)				
Hawke's Bay	5.4	48	13	8	31	7	25
Rotorua	6.4	35	5	11	21	8	11
Northland	6.1	34	17	11	40	13	8

Hawke's Bay site

Table 3 shows the periodic DM yields and total DM yield for the Hawke's Bay site. During Cut 1, there were no significant differences among the treatments although the control treatment had the lowest DM yield. During Cut 2, SustaiN gave the highest yield relative to the EEF treatments which were all comparable. During Cut 3, yields tended to decline due to the dry weather. Nevertheless, SustaiN100 and StrategeN100 continued to have the highest yields. During Cut 4, DM yields recovered due to higher soil temperature and some increase in soil moisture. The highest yields were observed with StrategeN followed by Sustain and the Sustain:StrategeN mix. For total DM yield, SustaiN, StrategeN and the Sustain-StrategeN mix gave the highest yields which were significantly better than the control treatment. Product 1 performed consistenly rather poorly.

Table 3. Pasture DM yield per cut and total DM yield (kg/ha), Hawke's Bay site.

Treatment	Cut 1 30 Aug [11°C]	Cut 2 19 Sep [15°C]	Cut 3 10 Oct [15°C]	Cut 4 9 Nov [20°C]	Total DM Yield	% increase
Control	1305	846 c	745 c	1465 bc	4361 c	-
SustaiN	1577	1255 a	1140 a	1734 ab	5706 a	31
StrategeN	1492	1133 b	1071 ab	1816 a	5512 a	26
30%SustaiN+ 70%StrategeN	1506	1098 b	977 b	1652 abc	5233 ab	20
Product 1	1625	1021 b	776 c	1345 c	4767 bc	9
P value	0.2757	0.0001	0.0001	0.0227	0.0001	
LSD (0.05)	-	121	115	309	543	
cv (%)	22.3	12.5	13.4	21.3	11.7	

Within a column, means with common letters are not significantly different at P=0.05. Numbers in brackets are topsoil temperatures at 10 cm depth during harvest.

Rotorua site

Table 4 shows the periodic DM yields and total DM yield for the Rotorua site. During Cut 1, Product 1 gave the highest DM yield. However, this was not maintained in subsequent cuts. StrategeN caused a steady increase in yield from Cut 2 to Cut 4 but the magnitude of increase was lower compared with SustaiN. During Cuts 5 and 6, DM yield rapidly declined regardless of treatments. At Cut 5, StrategeN and SustaiN-StrategeN mix gave the highest DM yield. By Cut 6, StrategeN, SustaiN-StrategeN mix and Product 1 gave comparable yields; the SustaiN treatment produced significantly lower DM yield than the rest of the treatments. For total DM yield, the SustaiN+StrategeN mix, SustaiN, and StrategeN gave comparable yields, outperforming Product 1.

Table 4. Pasture DM yield per cut and total DM yield (kg/ha), Rotorua site.

Treatment	Cut 1 31 Aug [6°C]	Cut 2 23 Sep [12°C]	Cut 3 13 Oct [11°C]	Cut 4 3 Nov [12°C]	Cut 5 23 Nov [16°C]	Cut 6 12 Dec [14°C]	Total DM Yield	% inc.
Control	442 d	551 c	674 c	743 c	697 ab	600 a	3707 c	-
SustaiN	635 c	927 a	1220 a	949 b	602 b	465 b	4798 a	29
StrategeN	570 c	848 a	959 b	1031 a	748 a	567 a	4723 a	27
30%SustaiN+ 70%StrategeN	758 b	900 a	989 b	940 b	753 a	557 a	4897 a	32
Product 1	894 a	733 b	749 c	737 c	638 bc	568 a	4319 b	16
P value	0.0001	0.0001	0.0001	0.0001	0.0002	0.0007	0.0001	
LSD (0.05)	102	99	139	72	72	59	363	
cv (%)	17.0	13.7	16.7	9.0	11.5	11.8	8.9	

Within a column, means with common letters are not significantly different at P=0.05. Numbers in brackets are topsoil temperatures at 10 cm depth during harvest.

Northland site

Table 5 shows the periodic DM yields and total DM yield for the Northland site. In the first two cuts, Product 1 produced the highest yields but this was not sustained subsequently. From Cut 2 to 3, there was a decrease in dry matter yields in most treatments with the exception of SustaiN and StrategeN. At Cuts 4 and 5, substantial growth increases were observed in all the treatments due to warmer and wetter weather conditions. At Cut 5, StrategeN exceeded the DM yield of SustaiN while the Sustain+StrategeN mix was comparable to that of the SustaiN DM yield. At the last cut, DM yield from all treatments declined drastically. DM yield in the StrategeN treatment was significantly higher than that of SustaiN but was comparable to the SustaiN+StrategeN mix. For total DM yield, all fertiliser treatments were better than the control. However, Product 1 produced only a 15% increase in yield relative to control.

Table 5. Pasture DM yield per cut and total DM yield (kg/ha), Northland site.

Treatment	Cut 1 1 Jul [12.0°C]	Cut 2 3 Aug [12.4°C]	Cut 3 31 Aug [11.0°C]	Cut 4 30 Sep [14.7°C]	Cut 5 26 Oct [16.4°C]	Cut 6 22 Nov [17.5°C]	Total DM Yield	% inc.
Control	384 b	530 d	498 c	1072 c	1652 c	1004 bc	5140 c	-
SustaiN	497 a	597 cd	756 a	1622 a	1862 b	912 c	6246 ab	22
StrategeN	369 b	660 bc	681 b	1444 b	2098 a	1204 a	6456 a	26
30%SustaiN+ 70%StrategeN	523 a	724 ab	672 b	1363 b	1868 b	1094 ab	6244 ab	21
Product 1	545 a	767 a	635 b	1115 c	1809 bc	1030 bc	5901 b	15
P value	0.0001	0.0001	0.0001	0.0001	0.0023	0.0026	0.0002	
LSD (0.05)	65	73	67	154	203	139	540	
cv (%)	15.5	12.3	11.5	12.8	12.0	14.7	9.9	

Within a column, means with common letters are not significantly different at P=0.05. Numbers in brackets are topsoil temperatures at 10 cm depth during harvest.

Our results agree with those of Edmeades (2015) who showed that the application of 25kg N/ha and 50 kg N/ha in Rotorua and Northland as the controlled release SmartFert (the same fertiliser as StrategeN) had no significant effect on total DM yield relative to urea applied at the same respective rates. In contrast, the Taupo site he studied was more N responsive than the Rotorua and Northland sites and DM production from the SmartFert treatments was greater than from the equivalent urea treatments. Nevertheless, this effect was statistically significant ($P<0.05$) only at the higher 90 kg N/ha rate. A one-time application of SmartFert at 90 kg N/ha in the Taupo site gave a similar yield to three split applications of urea of 30 kg N/ha, suggesting that one of the benefits of controlled release N fertiliser is that less frequent applications can be made for the same pasture production outcome (Edmeades, 2015).

Conclusion

StrategeN (polymer-coated urea) and the 30% SustaiN:70% StrategeN mix gave comparable dry matter yields as the SustaiN treatment at the same 100 kg N/ha rate. On the other hand, Product 1 (methylene urea) generally produced lower yield than all the other treatments. While a single application of a slow release or controlled release N fertiliser to pasture represents a reduction in labour/application cost, this benefit will have to be weighed against its significantly higher cost per tonne relative to soluble N fertiliser like urea or SustaiN.

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