Land Research Services Client Report

Client: United Fisheries Ltd

The Effect of Bio Marinus Liquid Fish Fertiliser on Pasture Growth in Canterbury: Year 2 Trials

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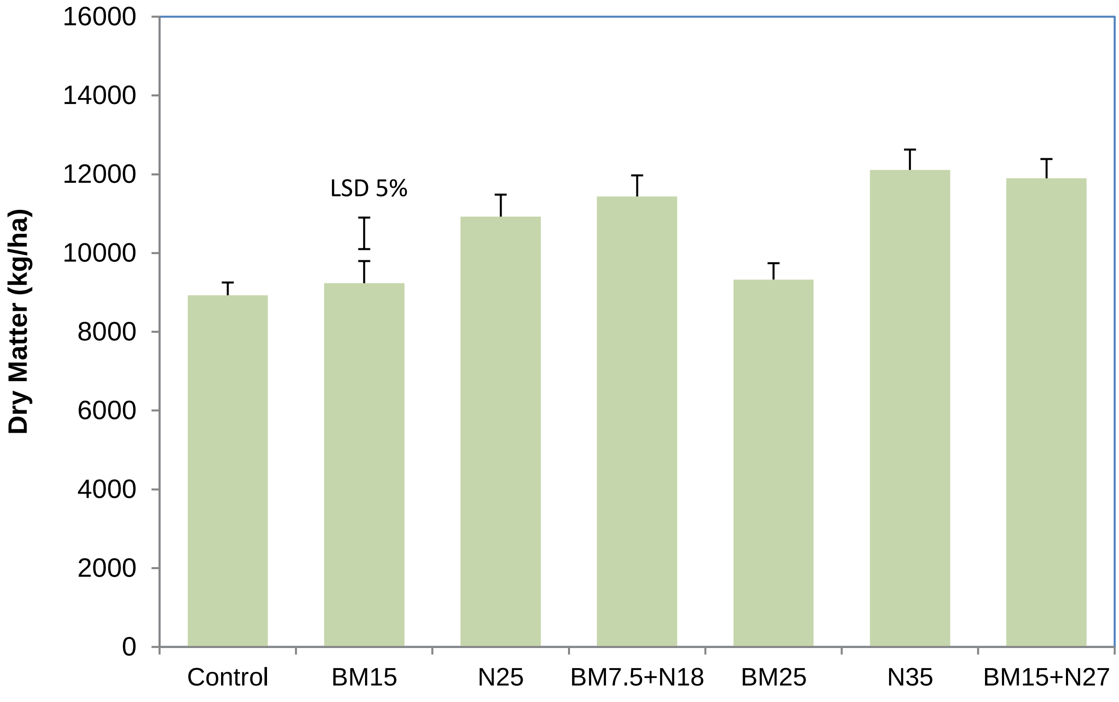
Summary of Trial Results

Trial sites were set out on two Canterbury dairy farms on a heavy silt (slow-draining) and a sandy loam (free-draining), respectively, to measure the performance of Bio Marinus (BM), a new liquid fish product (BM) developed by United Fisheries, by itself or in conjunction with nitrogen (N), applied as liquid urea. Pasture growth was measured on each trial plot during August-December 2011 and March-June 2012. Seven treatments including a control were applied as follows:

1. Control (no BM or N applied)
2. BM applied at 15 L/ha
3. Liquid N (urea) applied at 25 kg N/ha
4. BM and liquid N applied at 7.5 L/ha and 18 kg N/ha, respectively
5. BM applied at 25 L/ha
6. Liquid N applied at 35 kg N/ha.
7. BM and liquid N applied at 15 L/ha and 27 kg N/ha, respectively

Results of the spring and autumn application pasture trials showed a modest overall (figure below) increase in DM production from applying BM+N to N-alone despite the application rates of N in the combined treatments being only about two-thirds that of the N-alone treatments. Most of this increase was recorded at one site (Greenpark) and generally, the lower rate of BM+N gave the best response compared to the lower N-rate at both sites. There was no significant response to BM alone at either site. Nitrogen-use efficiency was greatest overall for the BM+N1 treatments for both trials followed by BM+N2 and then the two N-only treatments.

Pasture feed quality and nutrient content was similar between treatments at both sites although ME values for the BM-N treatments were generally higher than the N-only treatments for both sites. Overall, feed quality measured as ME, was slightly higher at the Greenpark site. Calcium and Mg pasture concentrations were about 10% higher in the BM+N treatments over the N-only treatments but otherwise were similar for other major and micro nutrients.



Average total DM production for Spring-Autumn growth for two Canterbury dairy pasture trials. Treatment units: BM- L/ha; N- kg/ha.

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1 Introduction

In 2010 Land Research Services (LRS) Ltd undertook a set of preliminary trials to test a new fish liquid fertiliser product (Bio Marinus) produced by United Fisheries Ltd from the waste by-product of fish processing. In 2011-12 we expanded those trials to reduce the number of treatments but increase replicates at two trial sites in Canterbury. Analysis of Bio marinus's (BM's) composition has already shown that it comprises useful amounts of N, P K, S and trace minerals. The makers promote Bio Marinus as a biological aid to soil micro-organisms and soil health as well as a naturally-based fertiliser product.

The approach was to measure BM's performance on pasture growth, both separately, and in conjunction with N, in two separately-located trials on Canterbury dairy pastures located on impeded and free-draining soils. The trials were specifically aimed at measuring effects in spring and autumn and were from August-to-December 2011 and March-to-June 2012, respectively. Measurements were of dry-matter production, nutrient composition and quality.

2 Material and methods

2.1 Field site and soils

The two trial sites were the same as those used in 2010-11 and located on dairy farms in the Springston and Greenpark areas on pastures consisting of a dominant perennial ryegrass/white clover. Both trials were irrigated when required with rotating booms.

The Springston site (Plate 1) is the dryer of the two sites, being on an Eyre soil (Immature Pallic). These soils are generally shallow sandy-to-silt loams although this site is relatively stone-free to at least 25 cm (NZDSIR,1968).

The Greenpark site (Plate 2) is on a Taitapu soil (Gley Recent). These are mostly silt loams but these soils are generally wet in winter and poorly-drained as a general rule. In summer, they require less irrigation, at least initially but will dry out in summer and require irrigation to maintain growth (Hewitt 1993).

A low quicktest potassium value at the Greenpark site meant a dressing of 75 kg K/ha was applied prior to the trial commencing and a further 50 kg K/ha was applied to both trials midway through the applications. No superphosphate was applied to either trial as Olsen-P levels were considered adequate (Table 1).

Soil temperature was recorded at each site and NIWA Lincoln averages for rainfall and temperature over the two application periods were collated and presented together with recent averages (1999-2012) for Lincoln.

Plate 1. **Springston trial site (Eyre immature pallic soil; free-draining**

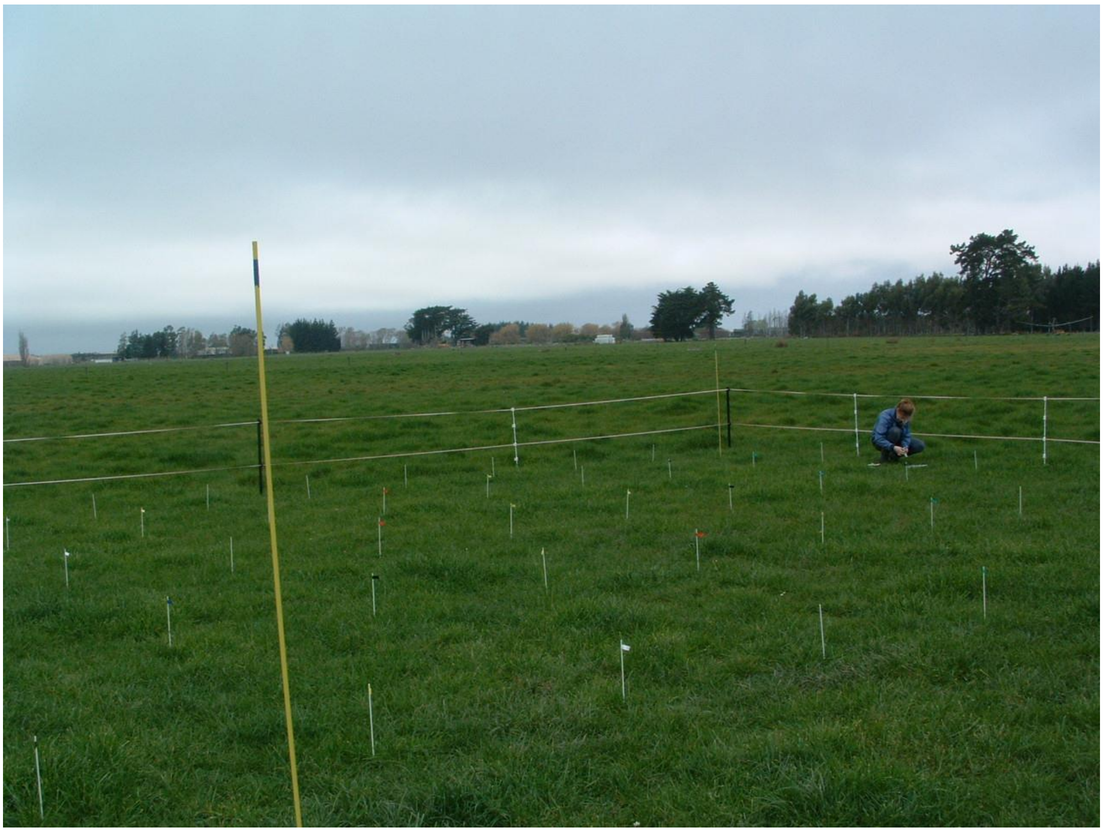


Plate 2. **Greenpark trial site (Taitapu gley recent soil; slow draining).**

2.2 Treatments

A series of seven treatments replicated a total of nine-times at each site (63 plots in total per site) were applied to the two trials using BM and N-alone, and in combination with each other. All treatments were applied as solutions (N applied as liquid urea) and sprayed on to the pasture surface directly about a day after each cut was taken using stated application rates in a total volume of 200 L/ha. The treatments were as follows:

1. Control (no BM or N applied)
2. BM applied at 15 L/ha
3. N applied at 25 kg N/ha
4. BM and N applied at 7.5 L/ha and 18 kg N/ha, respectively
5. BM applied at 25 L/ha.
6. N applied at 35 kg N/ha
7. BM and N applied at 15 L/ha and 27 kg N/ha, respectively

2.3 Harvesting

Harvests were conducted approximately 1 month later after each application with four harvests in the spring-early summer months from September-to-December 2011 and a further two in the autumn months over April-June 2012. DM yields were measured from each plot whilst nutrient content was measured in a composite sample for each treatment taken from subsamples of the dry-matter weighed from each plot for each harvest.

Table 1. Pre- and post- trial soil test results for selected soil chemical properties. Units: BM- L/ha; N kg N/ha.

Trial Site	pH	Ols-P (mg/L)	SO_4-S (mg/kg)	CEC (me/100g)	Ca (QTU)	Mg (QTU)	K (QTU)	Na (QTU)	BS Total (%)
Greenpark initial	6.1	29	48	22	14	62	3	27	84
Gpk Control	6.2	15	36	22	13	69	5	34	80
Gpk BM15	6.3	22	39	25	15	74	5	34	82
Gpk N25	6.2	18	20	21	12	63	3	27	81
Gpk BM7.5+N18	6.2	16	32	21	12	62	4	28	81
Gpk BM25	6.2	17	34	23	14	66	4	30	80
Gpk N35	6.1	19	24	23	12	60	4	29	80
Gpk BM15+N27	6.1	20	24	22	12	59	3	26	80
Springston initial	6.1	25	8	11	7	31	7	13	69
Spr Control	6.0	13	5	13	7	27	3	10	62
Spr BM15	6.1	18	4	14	8	30	4	11	63
Spr N25	6.0	13	6	13	7	27	4	9	61
Spr BM7.5+N18	6.1	13	3	14	8	31	4	8	63
Spr BM25	6.1	12	5	13	7	29	4	12	65
Spr N35	5.9	10	3	13	7	23	4	8	60
Spr BM15+N27	5.9	10	2	14	7	26	3	9	63

Table 2. Region rainfall and temperature, and site soil temperature (0-10 cm) for the two trial periods (2011-12) compared with recent-term averages (1999-2011) for Lincoln.

Climate and soil temperature	*Greenpark*		*Springston*		*Recent term means*	
	Aug-Dec 2011	*Mar-Jun 2012*	*Aug-Dec 2011*	*Mar-Jun 2012*	*Aug-Dec 1999-2012*	*Mar-Jun 1999-2012*
Rainfall (mm)	270	174	270	174	280	206
Avg. air temp (°C)	11.7	10.0	11.7	10.0	11.5	10.9
Avg. 10 cm soil temp (°C)	12.7	9.3	13.3	10.8	10.5	9.2

Table 3. Approximate nutrient content of the Bio Marinus (BM) fish fertiliser.

Macronutrients (%)						
N	**P**	**K**	**S**	**Ca**	**Mg**	
2.4	1.8	0.35	0.24	0.3	0.04	
Micronutrients (mg/L)						
Fe	**Mn**	**B**	**Cu**	**Zn**	**Mo**	**Co**
350	144	8	36	15	19	1.4

Table 4. Cumulative amounts of major nutrients applied for each treatment.

Treatment	**Rate BM (L/ha)**	**N**	**P**	**K**	**S**
		kg/ha			
BM15	15	2	2	0.2	0.2
N25	0	150	0	0	0
BM7.5+N18	7.5	109	1	0.1	0.1
BM25	25	4	3	0.3	0.4
N35	0	210	0	0	0
BM15+N27	15	164	2	0.2	0.2

3 Results and Discussion

3.1 Rainfall and climate

Soil temperature at the Greenpark site was, on average, slightly cooler than the Springston site, as predicted, but both sites were warmer for the two periods than recent-term averages for Lincoln. Rainfall was slightly lower than recent-term averages, particularly in the March-June period although this was compensated by irrigation.

3.2 Dry matter yields

Dry-matter (DM) production for all treatments for the 4-month spring (cuts 1-4) and 3 month (cuts 5-6) autumn periods are shown individually, and in total, in Table 5 (cut 2 for Springston was not included- see footnote[1]) Summaries of the total production for each treatment for both trials overall, and in each trial separately, are shown in Figures 1 and 2.

Generally, there was a weak response to BM-only and there were no statistically significant responses to BM from the control (Figure 1 and Table 5) although the Springston trial possibly responded slightly better (Figure 2). Overall, BM used in combination with N (applied as liquid urea) produced similar or better DM responses than N-only treatments, especially at the lower rate of application (BM 7.5 L+N18 kg N/ha). Although there were no significant differences between N-only and BM+N treatments overall, there were in cuts 1, 2 and 4 for the Greenpark trial but none for the Springston trial. We are unsure why the Springston trial did not respond similarly to the Greenpark trial. It could be that there was considerably less clover present at the Springston site or the slightly cooler site at Greenpark responded better to the impetus provided by the BM+N treatments but it's difficult to say. As there was ~50% more N in the N-only treatments than the BM+N treatments we can at least say that there is some type of synergistic effect of BM and N both working together better than separately, at least over the spring and autumn periods they were measured over. This was also backed by the statistical contrasts that showed that the effect of BM from BM+N was a highly significant effect ($P<0.001$).

Increasing rates of application of BM, whether singly, or in conjunction with N, did not consistently increase production over the lower rate and consequently, there were few significant differences between rates (Table 5). This would seem to suggest that the BM application need only be at a rate of around 10 L/ha in combination with N to provide a benefit. However, it needs to be pointed out that BM is not, for the most part, providing a significant fertilising effect as the applied nutrients are small (Table 4).

[1] A batch of BM did not appear to behave as earlier batches or subsequently, so the harvest data associated with this batch was removed from the data pool.

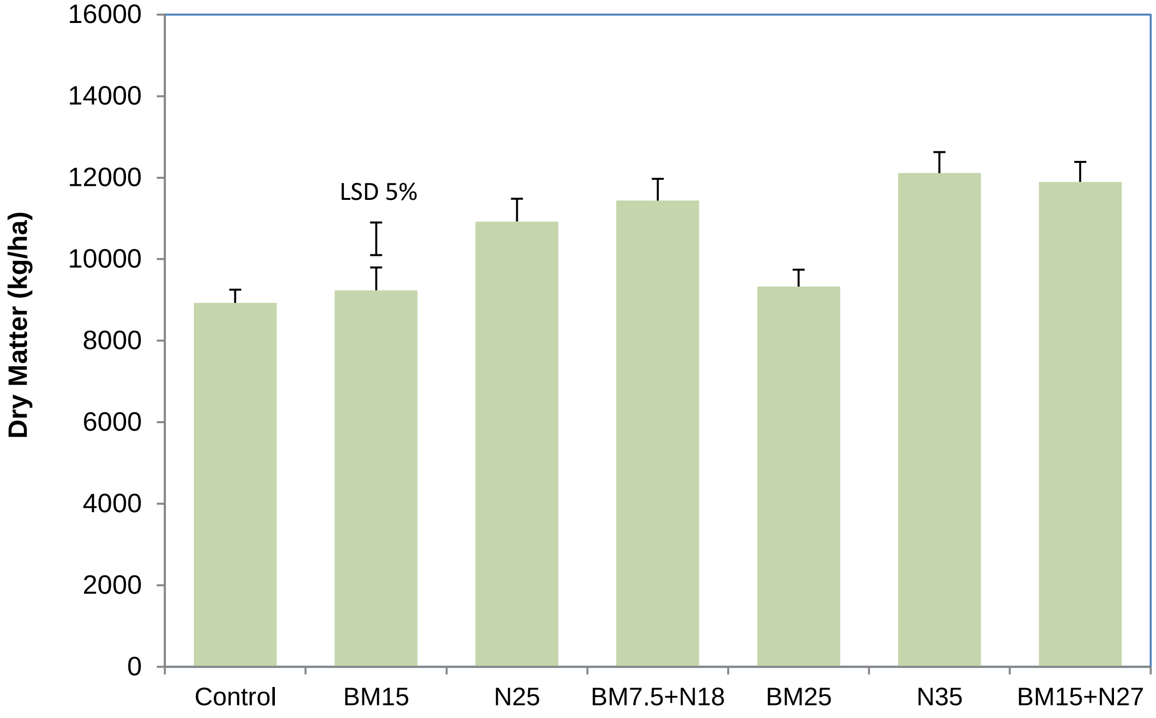


Figure 1. **Overall DM production (2011-12) for each treatment compared with no fertiliser use (control) for both mowing trials (Spring and Autumn cuts combined). LSD (5%) bar shown for treatments overall.**

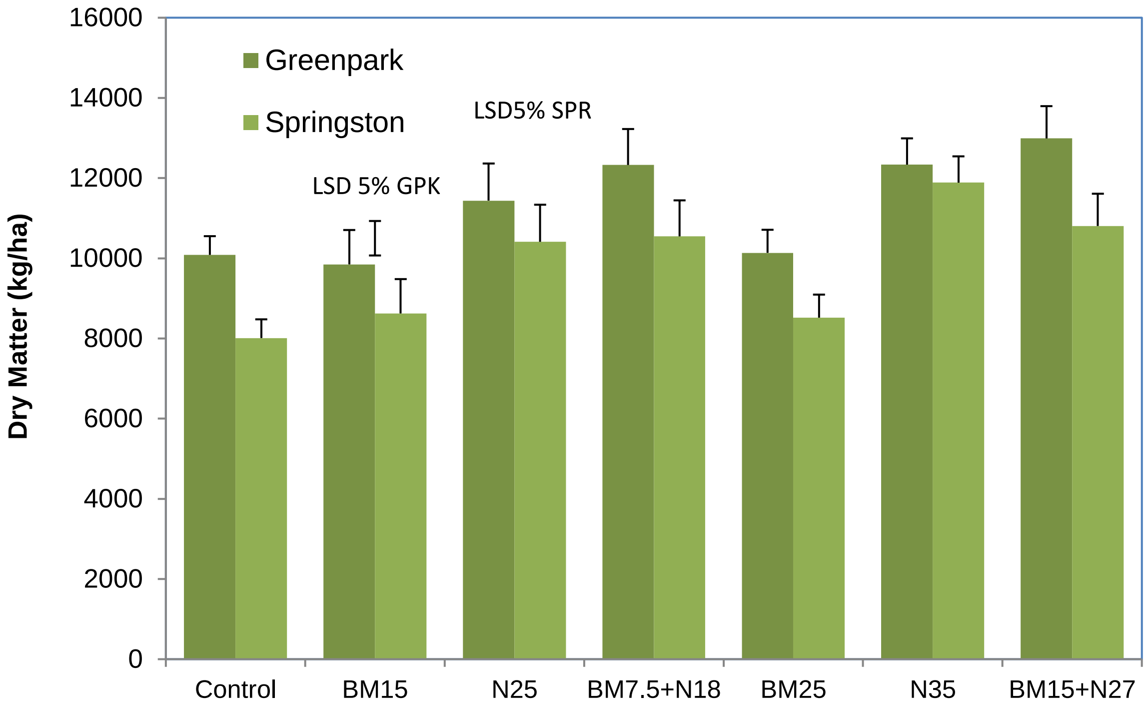


Figure 2. **Total DM production for two Canterbury dairy mowing trials using Bio Marinus and/or N (Sept-Dec 2011; Mar-Jun 2012). LSD bars indicate where differences between columns of the same trial are significant at 5% level.**

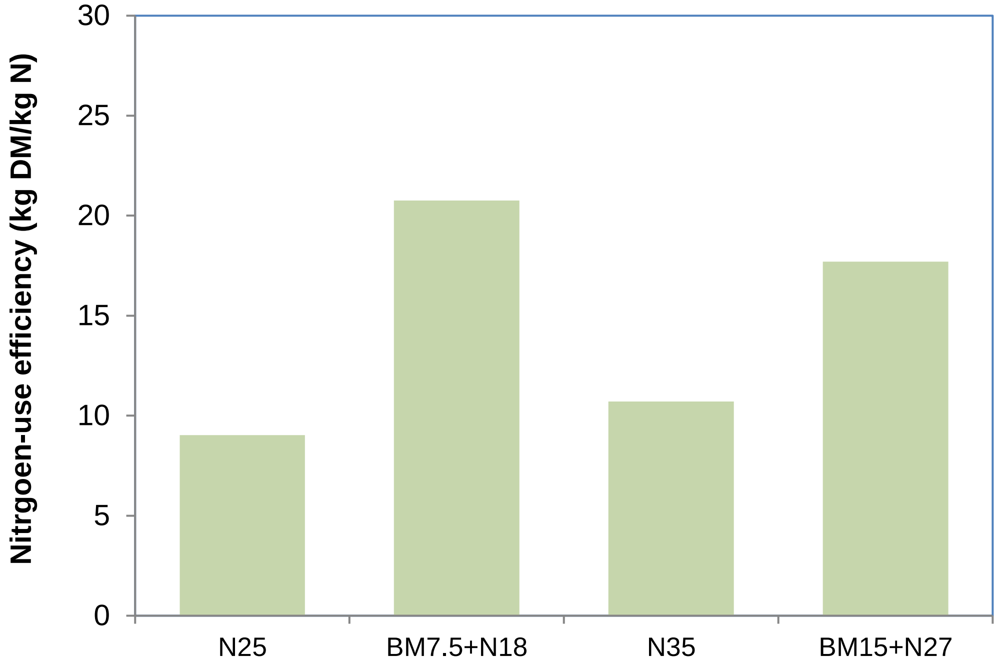
Table 5. Individual, total and sub-total DM production values for Greenpark, Springston and Site overall for all treatments. Spring period- cuts 1-4; autumn period- cuts 5-6. Total treatments that are significantly different from each are denoted by different letters.

	Greenpark						
Treatments	**Cut 1**	**Cut 2**	**Cut 3**	**Cut 4**	**Cut 5**	**Cut 6**	**Total**
Control	2084	1448	2145	2094	1493	839	10105
BM 15	1969	1550	2088	1949	1568	723	9847
N25	2250	1772	2505	2076	1731	1104	11438
BM7.5+N18	2864	2031	2200	2269	1760	1201	12326
BM25	2144	1519	1974	2167	1656	676	10136
N35	3009	1923	2331	1901	1717	1455	12335
BM15+N27	2945	2188	2402	2277	1777	1399	12989
LSD (5%)	399	187	525	326	235	191	1326
	Springston [a]						
Control	2203	-	1482	2051	1624	650	8010
BM15	2398	-	1666	2225	1650	682	8623
N25	2773	-	2073	2590	1906	1069	10411
BM7.5+18N	2946	-	2103	2656	1918	925	10547
BM25	2248	-	1773	2093	1683	722	8519
N35	3633	-	2295	2794	2012	1153	11886
BM15+N27	3194	-	1958	2696	1893	1063	10805
LSD (5%)	387		370	289	203	152	862
	Overall [b]						
Control	2187	1448	1814	2072	1559	745	8928
BM 15	2184	1550	1877	2087	1609	703	9235
N25	2512	1772	2289	2333	1819	1086	10925
BM 7.5+N18	2905	2031	2152	2462	1839	1063	11436
BM 25	2196	1519	1873	2130	1670	699	9327
N35	3321	1923	2313	2348	1864	1304	12111
BM 15+N27	3070	2188	2180	2486	1835	1231	11897
LSD (5%)	277	187	287	244	151	123	800

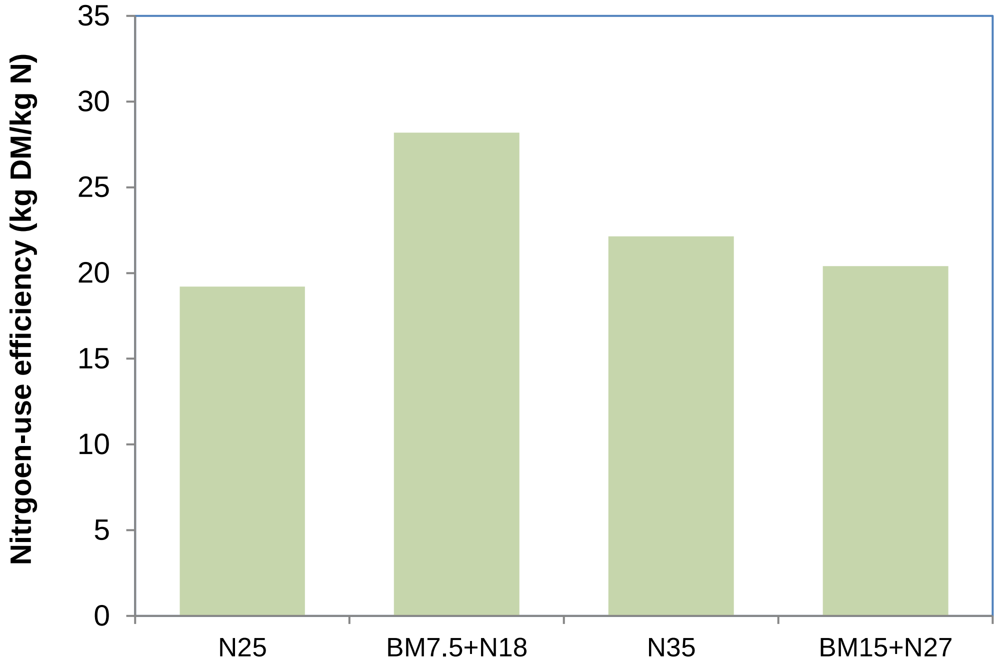
[a] Cut 2 for Springston was excluded from the total analysis due to a question over a batch of BM that did not perform to expectation as pre- and post-applications; [b] excludes Springston cut 2.

3.3 Nitrogen-use efficiency

Average nitrogen-use efficiency was calculated for each of the main N application treatments (Figure 3) for each trial. N-use efficiency is defined as the kg of dry-matter produced per unit N applied over and above that achieved in the control treatment. The BM+N1 treatment clearly led BM+N2 followed by the two N-only treatments in both trials. If the cost of BM doesn't outweigh the increases achieved in DM production then the addition of BM with N application can be considered a useful tool to increase DM production at the start of each growing season, particularly.



(A)



(B)

Figure 3. Greenpark (A) and Springston (B) spring-autumn average nitrogen-use efficiency for all N treatments. Units: BM- L/ha; N- kg/ha.

3.4 Pasture quality

Pasture quality measured for both Spring and Autumn was high for both trials (optimum range- ME 10-11) and similar between treatments for both sites although it was slightly better overall at the Greenpark site for most quality measurements. Metabolisable energy (ME) was higher overall for the BM+N treatments but it was not possible to say if this was significantly so due to the bulking of samples. High energy content (ME) of feed is a desirable quality and is calculated from a number of the feed quality measurements and correlates highly with digestibility (Hill Laboratories 2012a). Acid detergent and neutral detergent fibre comprise the less digestible fractions but these were all reasonably similar and overall, ME values were high for both trials (Hill Laboratories 2012b).

Nutrient content of pasture was also generally good for both trials overall although nitrogen (N) content was generally on the lower side of the optimum (range N; 3.0-4.0%), as was potassium (K; 2.5-3.0%), but not majorly so. This is because multiple harvests remove large amounts of nutrients (e.g. 60 kg N/ha and 50 kg K/ha) and thus there is less for uptake than might otherwise occur under normal grazing. It is interesting to note that generally the combined BM+N treatment results showed 10% higher levels of Ca and Mg than the N-only treatments although whether this is due to uptake of nutrients applied in the BM is difficult to say. There were no obvious trends in trace-elements between treatments (Table 4) with most values within optimum ranges for Cu (range: 6-8 mg/kg) and Zn (14-20 mg/kg), the main micronutrients of interest.

Table 6. Pasture feed quality and major nutrient content for main treatments for Spring and Autumn sampling at Greenpark and Springston sites.

Season	Trt	ME	CP	Lipid	ADF	NDF	N	P	S	K	Ca	Mg
Greenpark		*MJ/kg*		%					%			
Spring	Control	12.3	19.3	3.6	23.8	41.0	3.0	0.36	0.32	2.4	0.60	0.20
	BM	12.1	17.3	3.6	24.8	40.9	2.7	0.37	0.31	2.5	0.58	0.20
	N	12.2	17.2	3.7	25.0	42.5	2.7	0.35	0.32	2.6	0.49	0.18
	BM+N	12.1	17.3	3.8	25.2	40.9	2.8	0.36	0.30	2.8	0.52	0.19
Autumn	Control	11.7	21.8	4.6	23.2	33.6	3.5	0.34	0.40	2.0	0.56	0.22
	BM	11.6	23.0	5.0	24.3	34.8	3.7	0.35	0.38	2.2	0.57	0.22
	N	11.5	22.0	5.1	23.8	34.1	3.5	0.36	0.38	2.2	0.52	0.21
	BM+N	11.9	22.6	4.6	22.8	30.6	3.6	0.35	0.40	2.2	0.55	0.21
Springston		*MJ/kg*		%					%			
Spring	Control	11.1	18.1	3.7	27.7	41.0	2.9	0.28	0.26	1.9	0.80	0.26
	BM	11.0	17.8	3.6	27.7	43.7	2.8	0.29	0.25	1.8	0.87	0.28
	N	11.2	17.1	3.6	26.8	44.3	2.7	0.26	0.22	1.7	0.67	0.25
	BM+N	11.2	19.0	4.0	26.6	41.1	3.0	0.28	0.23	1.7	0.82	0.29
Autumn	Control	11.4	17.9	4.3	25.9	40.2	2.8	0.38	0.34	2.3	0.57	0.23
	BM	11.5	18.5	4.4	25.4	42.3	2.9	0.38	0.34	2.2	0.54	0.22
	N	11.4	18.5	4.4	25.0	42.9	3.0	0.34	0.33	2.3	0.49	0.21
	BM+N	11.6	18.2	4.6	25.0	40.4	2.9	0.36	0.33	2.2	0.54	0.25

Table 7. **Micronutrient content for main treatments for Spring and Autumn sampling at Greenpark and Springston sites.**

Season	Trt	Cu	Zn	B	Fe	Mn
Greenpark				*mg/kg*		
Spring	Control	5.9	17	13.0	160	180
	BM	5.9	17	14.0	170	160
	N	6.0	18	11.2	130	125
	BM+N	6.2	18	12.0	130	150
Autumn	Control	8.1	23	12.0	130	51
	BM	8.3	25	13.0	110	48
	N	8.3	25	10.5	110	48
	BM+N	8.2	23	10.5	98	49
Springston				*mg/kg*		
Spring	Control	6.2	23	11.0	150	76
	BM	6.5	25	11.0	150	76
	N	5.8	26	7.8	126	70
	BM+N	6.2	25	9.9	130	67
Autumn	Control	6.8	23	10.0	98	70
	BM	7.1	23	8.6	82	63
	N	7.0	26	8.0	109	75
	BM+N	6.8	25	8.4	85	59

4 Summary

Results of the spring and autumn application pasture trials showed a modest overall increase in DM production from applying BM+N to N-alone despite the application rates of N in the combined treatments being only about two-thirds that of the N-alone treatments. Most of this increase was recorded at one site (Greenpark) and generally, the lower rate of BM+N gave the best response compared to the lower N rate at both sites. There was no significant response to BM alone at either site.

Pasture feed quality and nutrient content was similar between treatments at both sites although ME values for the BM-N treatments were generally slightly higher than the N-only treatments for both sites. Overall, feed quality measured as ME, was slightly higher at the Greenpark site. The combined BM+N treatment results showed 10% higher levels of Ca and Mg than the N-only treatments but otherwise were similar for other major and micro nutrients.

5 References

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