Effect of dairy effluent on DM yields and nutritive characteristics of perennial pasture in late spring and summer

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Abstract

A study determined the effect of rate of dairy effluent application on dry matter (DM) yield, nutritive characteristics and mineral content of a perennial pasture following harvesting for silage. Rates of effluent applied were 0, 15, 30, 45, 60 and 75 mm/ha. The effluent applied contained high levels of potassium (K) (445 kg/ML) and sodium (Na) (508 kg/ML) and moderate levels of nitrogen (N) (155 kg/ML). With effluent, DM yields at the first grazing where higher ($P<0.05$) than the control treatment (0 mm/ha). When effluent was applied at rates of 60 and 75 mm/ha, DM yields were higher ($P<0.05$) than for all other effluent treatments. At the second grazing, effluent treatments of 30mm/ha and above resulted in higher ($P<0.05$) DM yields than the control treatment. Pasture crude protein (CP) was higher ($P<0.05$) at the first grazing where effluent had been applied at rates of 30 mm/ha and higher, whilst by the second grazing this effect was only apparent at rates of 60 and 75 mm/ha. The concentration of K at the first grazing was higher ($P<0.05$) when effluent was applied, whilst both phosphorus and Na concentration were higher ($P<0.05$) at application rates of 30 mm/ha or higher.

This study indicates the potential to use dairy effluent to increase pasture DM yield during late spring and summer in dryland areas of southern Victoria. Further research is required to determine the impacts of long term dairy effluent use on pasture composition and environmental factors such as soil structure.

Media summary

Dairy effluent was used to increase the DM production and nutritive value of perennial pasture in late spring and summer.

Key Words

Crude protein, potassium, sodium, dairy effluent, irrigation

Introduction

It is estimated that only 50% of dairy farms in the non irrigated regions of Victoria have suitable dairy effluent systems and of these only 25% are managed effectively (IRIS Research 2000). Furthermore, the majority of farmers apply effluent to less than 10% of their available land, often to the same area each year. Whilst there is considerable information available on dairy effluent collection systems, little data exists on sustainable ways to use dairy effluent on farm for forage production. Studies in New Zealand (Goold 1980, Roach et al 2000) indicate substantial DM yield increase are possible when effluent is applied to perennial pasture, however, the climatic conditions under which these trials were conducted are different to those in southern Victoria

This paper reports results generated from the first year of a three year study that compares perennial pasture DM responses and changes in nutritive characteristics and mineral content to a range of dairy effluent application rates.

Methods

This study was conducted on a commercial dairy farm near Terang (38°14’S, 142°55’E) in western Victoria on a basalt derived fine sandy clay loam soil. A paddock was removed from the grazing rotation on 1 September 2002 and N was applied (50 kg N/ha) one week later. The pasture composition was predominantly perennial ryegrass (*Lolium perenne*), white clover (*Trifolium repens*), subterranean clover (*Trifolium subterraneum*) and tall fescue (*Festuca arundinacea*). On 16 October the pasture was harvested for silage with the cut material baled and removed from the paddock within three days of the harvest date. From 1 to 11 November, six levels of effluent, A (0), B (15mm/ha), C (30mm/ha), D (45mm/ha), E (60mm/ha) and F (75mm/ha) were applied to plots at the site. Treatments were randomly allocated to plots (12 m x 12 m) within each block, and replicated six times in a randomised block design. Effluent was applied via a pressurised spray system (Irrifrance, Bosch Engineering) with sprinklers located on a 12 m x 12 m grid system (corner of each plot) with each sprinkler able to deliver within a 90^o arc ensuring a uniform distribution. For each 12 m x 12 m plot a buffer zone of 2 m was established to minimise impacts from adjacent plots. Application rates did not exceed 15mm/ha/d to avoid lateral movement of effluent. Irrigation was only undertaken when wind conditions were such that drift did not occur.

All plots were grazed when the most advanced treatments attained a pre grazing mass of 2200-2800 kg DM/ha, apart from the final summer grazing when plots were grazed to consume accumulated material prior to growth commencing from autumn rainfall. All plots were grazed with a milking herd to a post-grazing pasture residual of 1300–1700 kgDM/ha.

Pasture DM yield (kg DM/ha) was estimated by measuring pre- and post-grazing pasture mass with a calibrated rising plate meter (Earle and McGowan 1979). Prior to each grazing, 30 randomly cut pasture samples (5 x 15 cm quadrat cut to ground level) per plot were collected. Samples were thoroughly mixed with a sub sample washed, dried (60^oC for 72 h), ground through a 1 mm screen (Tecator Cyclotec 1093 sample mill) and used to determine nutritive characteristics and mineral content. Analysis of samples for nutritive characteristics was undertaken at FEEDTEST, Agriculture Victoria, Pastoral and Veterinary Institute, Hamilton using near infrared spectroscopy. Metabolisable energy (ME) (MJ/kg DM) values were calculated from predicted DM digestibility values (SCA 1990). Mineral analysis of leaf and root was by a microwave digestion (Lautenenschlaeger 1989, Nackashima *et al* 1988)) followed by Inductively Coupled Plasma - Optical Emission Spectroscopy (SCL 1987). Statistical analysis was undertaken using analysis of variance (ANOVA) (GenStat Committee 2000) with significance declared if $P<0.05$.

Results

Initial soil tests prior to effluent application were: pH (H_2O) 5.25, Olsen P 33.5 mg/kg and Skene K 160 mg/kg. The composition of effluent is presented in Table 1 and indicates that the effluent had a high content of both potassium (K) and sodium (Na).

Table 1. pH (H_20), electrical conductivity (EC) (dS/m), sodium adsorption ratio (SAR), phosphorus (P), potassium (K), sulphur (S), nitrogen (N), calcium (Ca), magnesium (Mg), sodium (Na) (mg/L) of effluent

	pH	EC	SAR	P	K	S	N	Ca	Mg	Na
Mean	7.95	4.3	6.1	23.3	445	22	155	170	220	508
s.d	0.058	0.14	0.15	1.50	12.9	4.1	10.0	8.2	11.6	17.1

Dry matter yields at the first grazing showed an increase ($P<0.05$), irrespective of effluent application rate, compared to the dryland control (Table 2). Furthermore, application rates above 30 mm/ha also increased ($P<0.05$) DM yield compared to the 15 mm/ha application rate. Where effluent was applied at rates of 60 and 75 mm/ha, DM yields were higher ($P<0.05$) than for all other treatments. This effect carried through to the next grazing, where the DM yield from the control was lower ($P<0.05$) than for treatments receiving 30mm/ha or more effluent. The DM yield of B (15 mm/ha) was also lower ($P<0.05$) than D, E and F, whilst treatment F gave rise to a higher ($P<0.05$) DM yield than C. There were no differences in DM yield at the two subsequent grazings.

Total DM yield over the late spring and summer period for all effluent applications rates were higher ($P<0.05$) than the dryland control. Application rates at 30 mm/ha and above also led to higher ($P<0.05$) DM yields than the 15 mm/ha (B) application rate.

Table 2. The effect of different effluent application rates (A 0; B 15; C 30; D 45; E 60; F 75 mm/ha) on pasture dry matter yield (tDM/ha) over subsequent grazing periods in late spring and summer

Effluent rate	Grazing 1	Grazing 2	Grazing 3	Grazing 4	Total yield
A	1.08	0.41	0.93	-0.16	2.26
B	1.57	0.45	0.80	-0.03	2.79
C	2.06	0.59	0.90	-0.02	3.53
D	2.10	0.64	0.94	-0.09	3.59
E	2.41	0.67	0.80	-0.06	3.83
F	2.32	0.75	0.90	0.07	4.03
l.s.d (P=0.05)	0.244	0.153	0.21	0.224	0.335

Effluent application 60 and 75 mm/ha led to an increase ($P<0.05$) in CP compared to all other treatments at grazing 1 (Table 3). In addition, effluent at 30 and 45 mm/ha led to an increase ($P<0.05$) compared with the control. At the first grazing, there was an increase ($P<0.05$) in neutral detergent fibre (NDF) with applications of 45 and 75 mm/ha compared with the control treatment. At the second, the CP content of A was lower ($P<0.05$) than where effluent was applied at 60 mm/ha and higher (Table 3). The ME of pasture was higher ($P<0.05$) than the control at the second grazing when effluent was applied at rates of 30 mm/ha or higher. At the third and fourth grazings there were no differences in the nutritive characteristics of the pasture (data not presented).

Table 3. The effect of different effluent application rates (A 0; B 15; C 30; D 45; E 60; F 75 mm/ha) on pasture metabolisable energy (ME) (MJ/kg DM), crude protein (CP), neutral detergent fibre (NDF) and water soluble carbohydrate (WSC) (%DM) contents

	A	B	C	D	E	F	l.s.d (P=0.05)
			Grazing 1				
ME	10.5	10.7	10.7	10.9	10.7	10.7	0.33

CP	13.3	14.8	16.1	17.1	19.5	19.0	1.83
NDF	60.4	61.0	62.3	64.5	62.5	63.3	2.49
WSC	14.0	12.2	9.7	7.4	4.7	4.5	2.35
				Grazing 2			
ME	10.0	10.1	10.4	10.3	10.7	10.4	0.22
CP	12.9	13.7	14.7	14.0	17.0	15.0	1.71
NDF	63.3	63.0	61.7	63.6	61.1	64.4	2.01
WSC	11.1	10.1	10.4	10.0	8.7	8.1	2.10

Effluent at rates of 30 mm/ha or higher led to an increase ($P<0.05$) in phosphorus (P) and Na content of the pasture compared with the control and lowest application rate of effluent at the first grazing (Table 4). Where effluent was applied the K content of pasture was higher than the control treatment, whilst application of effluent at rates of 45 mm/ha and higher (D, E, F) resulted in an increase ($P<0.05$) in sulphur (S) and magnesium (Mg) content compared to treatment A.

By the second grazing only treatment F had a higher ($P<0.05$) P content than the control. Potassium content was lower ($P<0.05$) in A and B compared to all other treatments, and Na content was higher ($P<0.05$) for treatments E and F compared to the control treatment. There were no differences in mineral content of pasture at the third or fourth grazing (data not presented).

Table 4. The effect of different effluent application rates (A 0; B 15; C 30; D 45; E 60; F 75 mm/ha) on pasture phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg) and sodium (Na) (%DM) contents

	A	B	C	D	E	F	l.s.d. (P=0.05)
				Grazing 1			
P	0.28	0.3	0.33	0.38	0.38	0.38	0.030
K	2.17	2.57	2.92	3.47	3.55	3.52	0.279
S	0.25	0.25	0.27	0.31	0.31	0.31	0.025
Ca	0.48	0.50	0.51	0.45	0.55	0.51	0.091

Mg	0.24	0.25	0.27	0.29	0.32	0.29	0.027
Na	0.39	0.45	0.49	0.56	0.64	0.64	0.099
				Grazing 2			
P	0.29	0.31	0.31	0.31	0.32	0.33	0.020
K	1.92	2.22	2.57	2.52	2.88	2.85	0.214
S	0.27	0.27	0.26	0.26	0.28	0.27	0.021
Ca	0.52	0.51	0.51	0.46	0.53	0.49	0.088
Mg	0.29	0.28	0.29	0.28	0.30	0.30	0.023
Na	0.41	0.42	0.48	0.48	0.53	0.53	0.078

Discussion and Conclusions

The concentration of nutrients within the effluent used for this study falls well within the ranges quoted by Kane (*pers comm*.) from a study of farms in south west Victoria. Furthermore, effluent composition is similar to that of Jacobs and Ward (2003) who found P, K and N levels of 35, 427 and 122 kg/ML respectively.

The DM yield responses of perennial pasture to applied effluent for the total measurement period range from 24 to 79% increase compared to the control treatment. Goold (1980), comments that application rates equivalent to 120 and 60 mm/ha over a 12 month period produced increases of 43 and 27% respectively. The data collected to date from Goold (1980) would indicate that responses are likely to be higher in this study, although the measurements need to be undertaken for a similar period of time before comparisons can be fully made. The primary change in nutritive characteristics was an increase in pasture CP at the higher effluent application rates over the first two grazings. These two grazings were within 6 weeks of effluent application and given that pastures were still growing (ie. moisture was not limiting) such a response would be expected (McKenzie *et al* 2003). The amount of N applied was 23, 47, 70, 93, 116 kg N, and whilst N responses would be expected even at the lower rate, a proportion of this N is likely to be unavailable for immediate utilisation by the pasture. Crocos and Wrigley (1993) comment that only 50% of the N within effluent is readily available for plant uptake, however it is unclear if this figure refers to effluent from 1st or 2nd ponds. The effluent used in this trail came from a 2nd pond and is likely to have gone through considerable breakdown during the storage period. Given that some of the N may be in an organic form, measurements of CP in pasture following the autumn break will provide valuable information on potential mineralisation of this N when moisture becomes available (Frame and Newbould 1986).

In conclusion, dairy effluent has the potential to increase DM yields of perennial pasture during late spring and summer, a period when feed is often limiting on dryland farms in southern Victoria. This study will continue for a further two years and assist in determining long term sustainable practices for the use of effluent in terms of achieving a balance between production and environmental implications.

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