EFFECTS OF NITROGEN FERTILISER ON PRODUCTION OF MILK SOLIDS FROM GRAZED PASTURE

A. M. BRYANT, K. A. MACDONALD, D. G. CLAYTON
Ruakura Animal Research Station, Hamilton

Abstract

In each of two years, eight 6.48 ha farmlets were used to assess effects of urea applications on dairy production. In the first year, 86 kg N/ha were applied in 2-3 dressings during May-August. Effects on annual milkfat and pasture production were not significant. In the second year 3-4 applications totalling 137 kg N/ha in April to September significantly increased annual milkfat and pasture production. Response in milkfat production per hectare to urea application averaged 0.22 (range − 0.16 to 0.45) and 0.25 (range -0.11 to 0.39) kg fat/kg N in the first and second years respectively. These responses were not economic at present-day prices.

INTRODUCTION

Increased dairy production from highly productive farms such as the Ruakura No. 2 Dairy requires increased feed production. This can certainly be achieved by use of crops such as maize (Campbell *et al.*, 1'978) and to a lesser extent, by irrigation (Hutton, 1978). It is also certain that these inputs will-not be widely adopted in traditional dairying areas for many years to come.

Pasture production can be increased by application of nitrogen(N) fertiliser (O'Connor and Cumberland, 1973). Costs are usually less than those of buying meal and use of N fits readily into existing management practices. It is most effectively used to alleviate anticipated feed shortages in late winter and early spring (Field and Ball, 1978; Steele et *al.,* 1981).

The only direct experimental evidence obtained in NZ on the extent that N fertiliser influences dairy production is that of Holmes and Wheeler (1973). They applied 790 - 941 kg urea/year for an extra 34 - 150 kg milkfat/ha, equivalent to a response of 0.08 - 0.35 kg milkfat kg N.

An experiment, not yet completed, to obtain further information on the effect of N fertiliser on dairy cow performance was established at the Ruakura No. 2 Dairy in May, 1979. Its objective is to examine the interactions among milk production, calving date, stocking rate and N fertiliser. This paper is a summary of the data obtained during the initial. two years, and is limited largely to the effects of N fertiliser.

EXPERIMENTAL

The No. 2 Dairy unit at Ruakura is on a number of soil types. They include Horotiu, Te Kowhai and Bruntwood silt loams and Te Rapa peaty loams. Mean soil test values of samples taken from all paddocks in May, 1979, were

8.6, 14.9, 39.1, 12.5 and 5.7 for Ca, K, P, Mg and pH respectively. Basal fertiliser of 500 kg/ ha of 30% potassic superphosphate and lime (I t/ha to one fifth of the farm) has been applied annually for a number of years. Present paddock layout was established in 1965-66. Extensive underdrilling with “Grasslands Ariki” ryegrass, “Grasslands Ruanui” perennial ryegrass and “Grasslands Huia” white clover has occurred since then. “Grasslands Nui” perennial ryegrass has been drilled into the whole area at least once since autumn, 1979.

Eight farmlets each consisting of four blocks of eight, 0.202 ha paddocks were involved each year. Design in the first year was a 2 x 2 factorial with two replicates. Factors were calving date and N fertiliser. Levels were early(E) and late (L) (mean calving dates, 28 July and 15 August respectively) and0 and 86 kg N/ha/ year. Stocking rate for each farm was 3.86 cows/ ha with no young stock.

The design in the second year was a 2 x 2 x 2 factorial with factors of stocking rate (3.86 v 4.32 cows/ ha), calving date (12 July v 15 August), and N fertiliser (0 v 137 kg N/ha/ year.) Times and rates of application are shown in Table I.

TABLE I: N FERTILISER APPLICATION: PERCENT ON FARM FERTILISED, TIMING, AND RATE OF APPLICATION.

	1979-80		1980-81	
Calving Date	Early	Late	Early	Late
April	—	—	23 (100)	23 (100)
May	57 (100)*	29 (100)	57 (100)	29 (50)
June		—	57 (50)	29 (25)
July	29 (100)	29 (100)	57 (125)	50 (100)
August		29 (100)	—	38 (75)
September	—		—	29 (SO)
No. of applications/ farmlet	2	3	3	4
Total N (kg/ ha)	86	86	137	137

*kg N/ha applied with percentage of farm in parenthesis.

The experiment started on 3 May, 1979. Drying off in the first year was on 14 and 28 April for the early and late calving herds respectively to allow reallocation of cows to treatments. Herds were dried off independently in the second year according to cow condition and feed supply.

The composition and yield of milk from each cow was measured at two consecutive milkings each week.

Herbage mass to ground level was visually assessed on all paddocks every week. Assessments were calibrated by cutting 15, 0.33m^2 quadrats. Pasture growth was calculated from the incremental yield on paddocks not grazed between consecutive assessments.

RESULTS

Cow Performance

The application of N fertiliser (+N) compared to no N (-N) significantly increased yields of milk and milkfat per cow and per hectare in the second but not the first year (Table 2). Milk protein content was increased by N in the first year but otherwise N was without effect on milk composition.

TABLE 2: EFFECT OF N FERTILISER ON COW PERFORMANCE

	1979-80 -N	1979-80 +N	Significance	1980-81 -N	1980-81 +N	Significance
Days in milk	252	252		241	246	
Milk (kg/cow)	3468	3500		3196	3377	*
Fat (%)	4.94	5.05		4.86	4.86	
Protein (%)	3.56	3.65	**	3.50	3.54	
Lactose (%)	4.84	4.85		4.90	4.88	
Fat — kg/cow	170	175		155	163	*
kg/ha	657	677		634	668	*
LW (kg)						
— at calving	399	403		391	397	
— at drying off	413	415		386	385	
Condition score						
— at calving	4.9	5.1		5.0	5.1	
at drying off	4.4	4.3		3.7	3.8	

In this and subsequent Tables,
(*) = $P < 0.10$, * = $P < 0.05$, ** $P < 0.01$, otherwise not significant.

Both liveweight and condition score the day after calving and at drying off were not affected by fertiliser treatment.

TABLE 3: MILKFAT YIELD IN EARLY LACTATION (kg/cow)

Weeks from Calving	1979-80 -N	1979-80 +N	Significance	1980-81 -N	1980-81 +N	Significance
1-8	46	51	**	41	44	**
9-16	40	42	*	41	44	*
17-24	38	37		38	40	

Per cow yields of milk and milk solids were increased by N in early lactation. This is illustrated by yields of fat for successive eight-week periods following calving (Table 3). In both years fat yield but not fat percentage fdr +N was higher than for -N in the first and second but not the third eight-week periods. Interactions between N and stocking rate or calving date for fat yield were not significant in either Table 2 or 3. This was also the case for most of the variables in Table 2.

TABLE 4: RESPONSE IN MILKFAT PRODUCTION -TO N FERTILISER (kg milkfat/ kg N)

	Calving Date Early	Late	Mean
1979-80			
Rep 1	0.45	0.45	
2	0.15	-0.16	0.23
1980-81			
Low S. Rate	-0.11	0.38	
High S. Rate	0.31	0.42	0.25
Mean	0.21	0.27	0.24

Response in milkfat production to N, calculated from the difference between +N and -N in per hectare yields of milkfat were variable (Table 4). Responses were negative in two of the eight comparisons. Mean response in the second year was higher than in the first, and that for late calving higher than early calving.

PASTURE GROWTH, MASS and BOTANICAL COMPOSITION

Pasture growth in the first year was significantly higher for +N than -N during winter and spring but significantly less during the summer (Table 5).

TABLE 5: EFFECT OF N FERTILISER ON PASTURE GROWTH AND MEAN HERBAGE MASS (kg DM/ ha)

	1979-80 -N	+N	Significance	1980-81 -N	+N	Significance
PASTURE GROWTH						
May-July	1542	1825	**	2366	2540	
Aug-Ott	3706	4470	**	5218	5974	**
Nov-Jan	6391	5167	**	6538	6748	
Feb-April	4606	4652		2850	2816	
Total	16253	16114		16973	18079	**
HERBAGE MASS						
May-July	1473	1535		1762	1873	
Aug-Ott	1321	1572	**	1485	1652	(*)
Nov-Jan	2466	2602	(*)	2922	3200	**
Feb-April	2637	2628		2755	2798	

Annual growth was similar for the two treatments. Response to N was 12.0 kg DM/ kg N during May to October but -1.6 kg DM/ kg N for the 12 months. The difference in summer growth was also reflected in milkfat yields. Additional fat for +N was 25 kg/ ha to the end of October but -6 kg/ ha subsequently. Annual and spring growth in the second year was significantly higher for +N. Responses were 6.8 kg DM/ hg N for May to October and 8.1 kg for the 12 months.

Herbage mass present on the +N farms were generally higher than on the-N farms in each year (Table 5). The differences were small, being a maximum of 250 kg DM/ ha in the spring of the first year and 280 kg DM/ ha in the second summer..

Botanical composition was similar on the +N and -N farms in May 1980 (62% grasses, 3 1% clover) and also in May 198 l (72% grasses, 24% clover). By contrast grass and clover content during October to December, 1980, was 82% and 16% respectively on the N farms and 74 and 23% on the -N farms.

CONSERVATION

Feed conserved in 1979-80 averaged 136 (range, O-199) and 191 (range 138-283) kg DM/ cow for the -N and +N treatments respectively. In 1980-8 I there was no conservation at the high stocking rate. At the low stocking rate, amounts conserved on the two -N farms were 33 and 54 kg DM/cow; for the +N farms they were 125 and 126 kg DM.

Supplementary feed used was similar for each treatment in both years. It averaged 211 and 245 kg DM/cow in the first and second years respectively.

DISCUSSION

The extra milkfat production due to N fertiliser varied greatly among treatments within years. It ranged from -0.1 l to 0.45 kg milkfat/ kg N with an average of 0.24 kg. It was not consistently greater for either high stocking rate or early calving, the treatments with the severest feed shortage in early lactation.

Ex-works price of urea in the Waikato was about $470/t at July, 198 1. If transport and application charges are taken as $0.15/ kg N (Steele et al., 198 1) then costs total $1.17/ kg N. At a milkfat price of $2.86/ kg, a response of0.41 of kg fat/ kg N is required to cover costs. Clearly, neither increased milkfat production nor increased profitability are necessarily consequences of N fertiliser application.

The N fertiliser consistently increased daily milkfat yields per cow in early lactation but not subsequently. The ability of the cows on the no N treatments to recover from relatively poorer feeding levels in early lactation was therefore a major factor acting to reduce the overall animal response to N.

The responses in milkfat production to N were closely related to changes in pasture growth and the amounts of pasture present on the farmlets. For example, both annual pasture growth and milkfat production were significantly increased by N in the second year, but not in the first year. Further, all parameters were increased by N in early lactation; but subsequently, particularly in the first year, both pasture growth and milkfat yields for +N were less than -N.

This concordance between pasture and animal response does not necessarily mean that the yield response of pasture to N measured in cutting trials will reflect accurately an animal response. This is because the response of pasture to N in cutting experiments may be different to that in grazing trials

(Jackson and Williams, 1979).

4 major objective of this study was to determine whether N fertiliser resulted in profitable increases in dairy production where per hectare production was already high. The amounts of fertiliser used were therefore higher than farmer practice of applying 25-50 kg N/ha to a portion of the farm. Experimental conditions were, however, chosen to ensure that any additional pasture growth was expressed largely as an increase in dairy production. Rates of response in milkfat production were similar in both years despite contrasting amounts of fertiliser applied. Furthermore, lesser amounts of fertiliser may have resulted in more efficient use of N but additional production of both feed and milkfat would also have been less. It is therefore likely that the use of N fertiliser on dairy farms with a climate and soil fertility similar to No. 2 Dairy will not be profitable.

ACKNOWLEDGEMENTS

Staff of No. 2 Dairy consisting of D. Aislabie, J.A.S. Lancaster, S. A. Nicol, R. van Kampen, H. T. M. Walker.

REFERENCES

Campbell, A. G.; Clayton, D. G.; MacDonald, K. A., 1978. *Proc. Ruakura Fmrs' Conf., Aglink* FPP166.
Field, T. R. 0.; Ball, Roger, 1978. *Proc. Agron. Soc. N.Z. 8:* 129-33.
Holmes, C. W.; Wheeler, J. S., 1973. *Dairyfmg A. 45-54.*
Hutton, J. B., 1978. *Proc. Ruakura Fmrs' Conf., Aglink* FPP167.
Jackson, M. W.; Williams, T. E., 1979. *J. agric. Sci., Camb. 92: 549-562.*
O'Connor, M. B.; Cumberland, G. L. B., 1973. *Ruakura Fmrs' Conf., 137-144.*
Steele, K. W.; O'Connor, M. B.; Ledgard, S. F., 1981. *Ibid, In* press.