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Effect of nitrogen fertiliser and summer rotation length on milk production in a dry Waikato summer

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ABSTRACT

Four 6.4 ha farmlets each stocked with 24 high genetic merit Friesian cows were used to determine the effect of nitrogen fertiliser (N), and a long summer grazing rotation on pasture and milk production in summer. Treatments were 0 (-N) or 50 kg N/ha (+N) in December, January and March and a 16 day (16) or 40 day (40) rotation. Treatments started 15 December, following a two week uniformity period, and ran until 29 April.

On the 16 and 40 day rotations N increased net herbage accumulation by 0.8 t DM/ha, and milksolids (MS) production by 92 and 38 kg/ha respectively. Across both nitrogen treatments, the 40 day rotation increased net herbage accumulation by 1.7 t DM/ha. The MS production was 39 kg/ha greater on the -N40 than the -N16 treatment whereas that of the +N16 and +N40 did not differ significantly.

The N and long rotation treatments also resulted in higher average herbage mass and cow condition at the end of the experimental period. It is concluded that N in early summer and a long summer rotation are useful management practices to reduce the effects of summer dry periods.

Keywords: Summer dry; Nitrogen fertiliser; grazing rotation; milk production.

INTRODUCTION

Feed shortages due to moisture deficit in summer and autumn, have resulted in a farming system where 75% of milk is produced in the first 175 days of lactation (Macmillan and Henderson 1987). Rainfall determines much of the between season variation in post-flush milk production (Bryant 1989). Ruakura has an average annual rainfall and evapotranspiration of 1230 mm and 998 mm respectively. From November to March (inclusive) the average rainfall is 427 mm and evapotranspiration is 650 mm, resulting in a moisture deficit of 223 mm over the summer and early autumn (Meteorological Service, 1980).

Hutton (unpublished data) increased net herbage accumulation by 20% using irrigation from January to March but application of nitrogen fertiliser (N) at 65 kg N/ha to unirrigated swards over the same period increased pasture production by 16%. Even so, the use of N in the summer is discouraged because limited data suggest N used during periods of moisture deficits will result in low pasture responses (During 1984).

Pasture production and clover persistence may be enhanced with a longer grazing rotation through the summer (T. Phillips 1993 pers. comm.). Furthermore, if N can be used to provide extra pasture in early summer, a longer grazing rotation may effectively ration the extra feed through the period of feed shortage. Increasing the spell after N application may also enhance N responses (Roberts *et al.*, 1992).

The aim of this trial was to determine if N applied in the summer and autumn increased pasture and milksolids production, and establish if this response was modified by grazing rotation.

MATERIALS AND METHODS

Four farmlets each consisting of 16, 0.4 ha paddocks were established at the DRC in December 1993. Each farmlet

was balanced for location, soil type and previous treatment. Farmlets were stocked with 24 high genetic merit Friesian cows (3.7 cows/ha) that had calved the previous July-August. Following a 2 week uniformity period, cows were allocated to the four treatment groups balanced for BI, milk production, cow condition, liveweight and age.

The trial design was a 2 x 2 factorial, the factors being 0, or 150 kg N/ha as calcium ammonium nitrate (CAN), and a 16 or 40 day rotation (-N16, -N40, +N16, and +N40). Nitrogen was applied at 50 kg N/ha in December, January and March. All herds were at a common rotation length of 16 days at the commencement of the trial on 15 December. In early January the rotation of one of the -N farmlets, and one of the +N farmlets was extended to 40 days.

Milk yield and content of fat, protein, and lactose was measured at two consecutive milkings each week. Cow liveweight and condition were measured fortnightly. Herbage intake was estimated for each herd weekly by DM disappearance, as measured by calibrated eye assessment. Net herbage accumulation of the farmlets was estimated from the increase in herbage mass on ungrazed paddocks, as measured by weekly calibrated eye assessment.

Milk production, liveweight and condition score data was adjusted for covariate analysis and analysed by analysis of variance.

RESULTS

Total rainfall at the DRC was 1097 mm in the year from 1 June 1993. Rainfall from 1 December 1993 to 31 March 1994 was 289 mm compared to the ten year average for the same period of 380 mm.

The N treatment increased total net herbage accumulation by 0.8 t DM/ha on both the 16, and the 40 day grazing rotation treatment (Table 1) representing a response of 5 kg

DM/ kg N applied. The extra pasture available to the +N16 herd resulted in 20% higher dry matter intake (DMI). Despite the large amount of extra pasture produced by the +N40 treatment the mean DMI for this herd was only 7% higher than that on the -N40 treatment.

The +N16 treatment produced significantly ($P<0.001$) more milk, milkfat and milk protein than the -N16 treatment (Table 1). The +N40 treatment produced more ($P<0.05$) milk and milk protein than the -N40, but the extra milkfat production was not significant.

TABLE 1: Net herbage accumulation, mean daily dry matter intake (DMI), and total milk, milkfat, and protein production from 15 December 1993 to 29 April 1994, cow liveweight and condition score on 1 April, and average herbage mass 29 April, 1994 of the 0 kg N/ha 16 day rotation (-N16), 0 kg N/ha 40 day rotation (-N40), and of 150 kg N/ha, 16 day rotation (+N16), 150 kg N/ha 40 day rotation (+N40) treatments.

	-N16	-N40	+N16	+N40	sed
Net herbage accumulation (kg DM/ha)	4396	6099	5183	6902	
Mean daily DMI (kg DM/cow)	11.8	11.6	14.2	12.4	
Herbage mass					
29 April (kg DM/ha)	2550	2967	2864	3300	
Milk yield (kg/ha)	5842 ^a	6356 ^b	7026 ^c	6863 ^c	239
Milk fat yield (kg/ha)	283 ^a	310 ^b	337 ^c	330 ^{bc}	10.7
Milk protein yield (kg/ha)	198 ^a	210 ^a	236 ^b	228 ^b	7.3
Cow condition score 1 April	4.2 ^a	4.5 ^b	4.5 ^b	4.5 ^b	0.1
Cow liveweight 1 April (kg)	447 ^a	455 ^{ab}	460 ^b	463 ^b	5.8

Means in the same row with differing superscript letters are significantly different ($P<0.05$).

The 40 day rotation treatment increased total net herbage accumulation by 1.7 t DM/ha for both the -N and the +N treatment. Extending the rotation reduced ($P<0.001$) milksolids production in January, but resulted in higher ($P<0.05$) milksolids production after 18 March. Over the experimental period, the -N40 resulted in 9% more milk and 10% more milkfat production than the -N16 treatment, however the additional milk protein produced was not significant. A lower milk protein content of the milk ($P<0.05$) produced by the herds on a longer summer rotation reduced the protein response relative to other milk components. Cows on a 40 day grazing rotation produced milk containing 33.5 g protein/kg and cows on a 16 day rotation produced milk containing 34.1 g protein/kg. Grazing rotation had no effect on milk production or composition when N had been used.

At the conclusion of the trial the -N16 treatment lower cow condition ($P<0.05$), and lower average herbage mass than the other three treatments. The nitrogen treatments resulted in higher ($P<0.01$) final mean cow liveweights, and the high net herbage accumulation of the +N40 treatment was evident in a higher average herbage mass.

DISCUSSION

Application of N in early summer significantly increased milksolids production in the summer and autumn. This increase was mediated through an increased DMI, not all

of which can be explained by increased herbage allowance. The average DMI of the +N16 herd was higher than the other herds, despite a lower total net herbage accumulation than the -N40 and +N40 treatments. A relatively low net herbage accumulation response to N applied during a dry summer agrees with the data of Ball and Field (1982). The pattern of rainfall and pasture production suggest the total response is a combination of a good response to the December N application, and a negligible response to the January N application. It should be noted that the estimates of NHA appear to have been underestimated on the +N16 day treatment, and over estimated on the 40 day rotation treatments when considered in light of the pasture DMI, milk production, and average herbage mass data.

The 40 day grazing rotation treatment confirms the findings of Bryant and Macdonald (1987) who compared a 10 and 40 day grazing rotation for 8 weeks from 23 January. The long summer rotation resulted in similar total milkfat production, but a higher liveweight gain, and a higher average herbage mass at the conclusion of the trial (Bryant and Macdonald 1987). In addition, the long rotation herds were producing at a higher level at the conclusion of the trial. These effects indicate the long rotation increased net herbage accumulation.

In the current trial, the increased net herbage accumulation may have been a result of the sudden increase in grazing pressure when the rotation was extended. Reduced herbage allowance forced the herds to graze a higher proportion of the sward in early summer. This hard grazing removed the majority of the old pasture resulting in only fresh material being carried into the summer period. On the short rotation treatments a lower proportion of the pasture was grazed. The higher post grazing herbage mass resulted in older pasture being carried into the summer as clumps. The older pasture presumably had a higher rate of senescence, which reduced the net herbage accumulation. The longer spell from grazing, and the higher average herbage mass may have also increased green leaf emergence.

CONCLUSIONS

The -N16 herd probably best represents the current practice of the majority of dairy farmers in the Waikato region. Not only did this system result in the lowest milk production, but at the end of lactation, the herd was the lowest in body condition, and there was the least amount of pasture on the farm. It is concluded that for highly stocked dairy farmers who farm in dry summer regions, an application of up to 50 kg N/ha in early summer, and a long summer rotation will both increase pasture and milksolids production, and put the herd in a better position at the end of lactation.

ACKNOWLEDGMENTS

The Authors thank the staff of the DRC No 3 dairy for animal management and pasture sampling, D.A. Clark and N.A. Thomson for advise during experimental planning, and Dr H.V. Henderson for statistical advise.

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