Early lactation response of dairy cows to pasture under two different nitrogen fertiliser regimes

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ABSTRACT

Twenty Jersey and 12 Friesian cows were individually offered freshly cut pastures that had received either 100-150 kg nitrogen (N)/ha (HN) or 25 kg N/ha (LN) as urea, either *ad lib.* or restricted to 70% of *ad lib.* Treatments were imposed for 2 consecutive 14-day periods during September and October 1993.

Effects of N fertiliser on the chemical and botanical composition of pasture were minor. There were no significant effects of N fertiliser on mean fat corrected milk yield, (19.9 kg/day 4.0% FCM), milk yield (16.2 kg/day), milk fat % (5.6%), milk fat yield (0.9 kg/day), or liveweight change (-0.59 kg/day). Milk protein yield ($P<0.05$) and protein % ($P<0.01$) were greater for LN than for HN treatment groups (0.58 vs. 0.56 kg/cow/day and 3.6 vs. 3.5%, respectively). Voluntary DMI was also affected by N fertiliser for cows on *ad lib.* pasture allowance (14.0 vs. 14.6 kg DM/cow/day for HN and LN treatments; $P<0.01$).

The application of N fertiliser in winter/early spring, had only minor effects on pasture intake or milk yield and composition in early lactation.

Keywords: Nitrogen fertiliser; cows; milk; protein; dry matter intake.

INTRODUCTION

Nitrogen (N) fertiliser has dramatic effects on pasture growth (O'Connor, 1982) and is used to increase pasture supply on dairy farms, especially in late winter/early spring. Associated effects of N fertiliser on aspects of feed intake by dairy cows and on their milk yield and composition have not been precisely defined.

Changes in the nutritive composition of pasture have been associated with N fertiliser usage. Pasture N concentrations were increased, while concentrations of non-structural carbohydrate (NSC), dry matter (DM) and neutral detergent fibre (NDF) were reduced with increasing N fertiliser application (Ross *et al.*, 1978; Westhafer, *et al.*, 1982; Wilman and Wright, 1983; Van Vuuren *et al.*, 1991). N fertiliser application has also been shown to influence the degradation of protein in the rumen of dairy cows (Van Vuuren *et al.*, 1991). These changes may be associated with differences in either feed intake or milk yield and composition.

The purpose of this study was to compare dry matter intake (DMI) of cows in early lactation as well as their milk yield and composition, when fed measured amounts of high or low N fertilised pasture.

MATERIALS AND METHODS

Twenty intact multiparous Jersey cows and 12 rumen-fistulated multiparous Friesian cows (average liveweight: 385 ± 33 (SD) kg and 410 32 kg, respectively: and at 39 ± 5 days postpartum), were allocated to 4 treatment groups balanced for milk yield, milksolids yield, liveweight (LW) and days in milk. The design was a change-over with a 2 x 2 factorial arrangement of 2 pasture N fertiliser treatments (High Nitrogen, HN; and Low Nitrogen, LN) and 2 allowance treatments (*ad libitum*; and restricted to 75% of voluntary DMI). Individual animals remained on the same allowance during both treatment periods, so that only the N treatments were reversed (HN to LN; or LN to HN). There were 4 periods (P1-P4). P1 and P3 were 7-day run-in periods when all cows were offered either HN or LN pasture, *ad libitum*, so that voluntary dry matter intake (DMI) could be calculated. Treatments were applied for 14 days during both P2 and P4, with data recording and sample collection for analyses, from days 8-14 only. All cows were housed and fed in individual stalls. The fistulated cows were housed in metabolism stalls that allowed the separate collection of faeces and urine, from days 8 to 14 in P2 and P4.

The mixed pasture of ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.) had received either 25 (LN), or 100-150 kg N/ha (HN) as urea since June 1993, with an interval of at least 3 weeks between the final application of urea and pasture harvest. Pastures were harvested twice-daily at 0700 and 1400 hours and fed individually to cows immediately after milking at 0900 and 1600 hours. Herbage mass at harvest was 3.2 and 2.6 t DM/ha for the HN and LN pastures, respectively (post-cutting approximately 1.5-1.8 t DM/ha). DM% of offered feeds and refusals were determined twice-daily by oven-drying triplicate samples at 100°C for 48 hours. Pasture samples were analysed using standard quality-controlled analytical procedures (AOAC, 1984). Milk yield (am + pm) was measured daily using a proportioning milk meter (Tru Test Co., Auckland, N.Z.) from days 8 to 14 during P2 and P4. Milk samples were analysed for protein, fat and lactose using a Milkoscan 133B (Foss Electric, Denmark).

One rumen-fistulated cow from the *ad lib.* allowance group was removed due to foot problems. Data from the remaining 31 animals were subjected to a general linear model (SAS Version 6, SAS Institute Inc., Cary, NC, USA) with cow, period, N fertiliser, allowance and the interaction between N fertiliser and allowance as the main effects.

RESULTS

N fertiliser effects on pasture chemical composition were small. Pasture DM % (15.4 vs. 14.6 %), organic matter % (88.4 vs. 88.9%), crude protein % (22 vs. 23%), total N % (3.54 vs. 3.68%), soluble N % (0.81 vs. 0.95%), soluble NPN % (0.53 vs. 0.69%), NSC minus starch (16.8 vs. 16.4%), *in vivo* digestibility (79.3 vs. 80.5%), NDF (46.2 vs. 47.3%), and acid-detergent fibre (21.7 vs. 22.0%) were all similar for the LN and HN treatments, respectively. The higher rate of N fertiliser appeared to decrease ryegrass content (82.8 vs. 76.6% of dry matter) and increase *Poa* spp. (5.3 vs. 8.3%) and weed contents (2.7 vs. 6.6%), while white clover was unaffected (7.2 vs. 7.2%).

Voluntary DMI was greater for the LN *ad lib.* group than the HN *ad lib.* group (14.6 vs. 14.0 kg DM/cow/day; P<0.01; Table 1). Fat corrected milk (FCM), milk yield, fat %, fat yield and LW change were not affected by N fertiliser treatment. However, milk protein % (P<0.01) and protein yield (P<0.05) were significantly higher for the LN treatment groups (Table 1).

Cows receiving the restricted allowance produced less FCM (P<0.01), protein (P<0.001) and fat (P<0.001), and their milk had a lower protein % (P<0.01). They also had a greater liveweight loss (P<0.001). None of the interactions between N fertiliser and allowance was significant.

DISCUSSION

The extra 75-125 kg N/ha that was applied to HN pasture over 3 months had little affect on pasture chemical composition. The relatively small increase in pasture N (0.14%) and decrease in pasture NSC (0.40%) observed in the current study agree with data from 32 plot trials, as reviewed by Wilman and Wright (1983), where a 0.16% increase in N and a 0.90% reduction in NSC, resulted from the first 100 kg N/ha applied to pasture. The small increase in N% observed in the present study under the HN regime, may be explained by the increase of 0.16% in soluble NPN, as was the case in the study of Ross *et al.*, (1978). Effects of level of N application on pasture chemical composition may have been less pronounced in the present study because pasture was not harvested until at least 21 days after cutting and N application (Dr. S. Ledgard, *pers. comm.*).

The LN *ad lib.* treatment group consumed 0.6 kg DM/cow/day more than their counterparts on HN. Reasons for this are not obvious, although this difference may have arisen from a combination of the higher DM% (15.4 vs. 14.6%) and the shorter leaf length apparent in the LN pasture. A cow offered HN pasture would have to eat approximately 5 kg more wet pasture than a cow on LN pasture to consume 14 kg/DM/day. Dittrich and Winklemann (1994) also found that wethers consumed more DM when silage was made from a low rather than a high N fertiliser regime. There was a trend for liveweight loss to be lower in the LN groups, which may have been due to their higher DMI, but there were no corresponding differences in milk yield or FCM (Table 1).

The higher rate of N fertiliser (HN) reduced milk protein % and milk protein yield, even though pasture chemical and botanical composition and milk yield were relatively unaffected by N treatment. Reasons for these effects are not clear. Despite the differences in DMI between *ad lib.* and restricted animals, there were no large differences in milk yield nor FCM. Liveweight loss was much greater for restricted animals, suggesting that these cows were able to maintain milk production at a greater cost to body reserves (Grainger and McGowan, 1982).

The results show that cows consuming herbage cut from spring pastures which had received higher rates of N fertiliser, ate less DM, produced milk with a lower protein % and had a lower milk protein yield. However, these small reductions in protein yield and voluntary DMI are insignificant, relative to the likely response of 15-24 kg of extra pasture DM grown for each 1 kg of N fertiliser applied in late winter/early spring (Harris *et al.*, 1994)

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TABLE 1: Least square means for dry matter intake, liveweight change, and milk yield and composition for high and low N pastures when fed to cows on *ad lib.* or restricted allowance (*n=31*).

	High Nitrogen		Low Nitrogen		SED[a]	SED[b]	Main effects	
	d lib.	Restricted	*ad lib.*	Restricted			Nitrogen	Allowance
Dry matter intake[c]	14.0	10.3	14.6	10.5	0.31	0.16	** d	***
Liveweight change[c]	-0.27	-1.12	0.01	-0.99	0.48	0.48	NS	**
Fat corrected milk[c]	20.7	18.9	20.9	18.9	0.68	0.39	NS	**
Milk yield[c]	16.5	15.6	16.9	15.6	0.84	0.28	NS	NS
Protein yield[c]	0.60	0.51	0.63	0.52	0.02	0.01	*	***
Fat yield[c]	0.94	0.84	0.95	0.84	0.04	0.02	NS	***
Protein %	3.70	3.32	3.81	3.36	0.14	0.03	**	**
Fat %	5.76	5.48	5.69	5.50	0.31	0.07	NS	NS

Note: [a] – Standard error of the difference when making comparison between allowance treatments
[b] – Standard error of the difference when making comparison between nitrogen treatments
[c] – kg/cow/day
[d] – Main effect of nitrogen treatment on dry matter intake of *ad lib.* cows only
NS – Not significant; * – P < 0.05; ** – P < 0.01; *** – P < 0.001

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