THE EFFECT OF LEVEL OF NITROGEN FERTILIZER AND SEASON ON MILK YIELD AND COMPOSITION IN COWS GRAZING TROPICAL GRASS PASTURES

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SUMMARY

The effect of level of nitrogen fertilizer on seasonal changes in milk yield and composition was investigated over two lactations. The nitrogen fertilizer treatments were 300 and 100 kg N/ha/year applied to Gatton panic (P. maximum cv. Gatton) pastures stocked at 2.6 cows/ha. Thirty-six Holstein-Friesian cows were used in each lactation. Over the full lactation, milk yield, butterfat yield, solids-not-fat yield, solids-not-fat % and lactose yield were all increased ($P< 0.01$) by the higher level of nitrogen fertilizer. The differences in production, which occurred mainly in autumn and winter, were attributed to the differences in green pasture on offer and amount of leaf in the diet.
Keywords: Lactation, milk composition, nitrogen, tropical pastures

INTRODUCTION

The introduction of milk payment schemes incorporating milk composition as a basis for payment in addition to total milk output has heightened producer interest in the factors affecting milk composition. Milk production systems based on tropical grass pastures are capable of high milk yields per hectare, but are associated with low levels of solids-not-fat, lactose and protein (Cowan 1986). The use of nitrogen fertilizer has been shown to produce economic increases in milk production (Davison et al. 1985), but little study has been done of the effects of level of nitrogen fertilizer on milk composition. This paper reports work from two years of a long term fertilizer study on the effect of level of nitrogen fertilizer on milk composition of Holstein-Friesian cows grazing a raingrown tropical grass pasture.,

MATERIALS AND METHODS

Location, pastures and treatments

The experiment was conducted at Kairi Research Station, north Queensland (17°14' S, 145°34' E). The climate is tropical upland with mean maximum and minimum temperatures of 28.9/18.3 °C in December and 20.9/10.9 °C in July. Long term mean annual rainfall is 1285 mm with 80% falling between November 'and April. Annual rainfall was 1107 and 1053 mm in 1985 and 1986 respectively.

Pastures were well established Gatton panic (Panicum maximum cv. Gatton) swards. The six treatments were laid out at random in four pasture replicates. Treatments were two levels of nitrogen fertilizer: 100 (100 N) and 300 (300 N) kg N/ha/year each'at three levels of phosphorus fertilizer: 0, 22.5 and 45 kg P/ha/year. Nitrogen was applied in four equal dressings during the growing season. As the level of phosphorus fertilizer had no effect on milk yield or composition, these treatments were ignored in the presentation of data. Molasses was offered at the rate of 3.5 kg/day to all cows.

Animals, measurements and analysis

At calving in November-December, six animals, consisting of four multiparous

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cows and two first lactation heifers were allocated to each treatment. Animals grazed experimental paddocks from December to September-October each year. cows grazed through the four pasture replicates on a 3½ day grazing, 10½ day spelling rotation at a stocking rate of 2.6 cows/ha. Cows had access to polytarp shade shelters and water was provided in each paddock. A coarse salt supplement was available at the dairy.

Milk yields were recorded five days each week and a composite milk sample (500 ml) from an afternoon and morning milking was taken once each week. This sample was analysed for butterfat and lactose content (Fossomatic). Solids-not-fat (SNF) content was determined once each fortnight, hydrometrically (British Standard 734) on the same sample of milk. Pasture on offer and its botanical composition were determined by hand cutting and sorting while botanical composition of the diet was determined by sorting samples collected by oesophageal fistulated cows (Davison et al. 1985), in January, April and August of both years.

Milk yield and milk composition data for each lactation were split into five periods of 8-9 weeks duration: November - December (1), January - February (2), March - April (3), May - June (4) and July - August (5). Milk yield, percentage and yields of butterfat, SNF and lactose were analysed by analysis of variance using variation between cows as the error term. The protein content of milk was estimated by difference from the SNF fraction assuming an ash fraction of 0.74%. Data were analysed for each period, and for total lactation, within and across years.

RESULTS

Over the full lactation, milk yield, butterfat yield, SNF yield,- SNF % and lactose yield were all increased' ($P<0.01$) by the higher level of nitrogen fertilizer (Table 1). Butterfat % and lactose % also increased with the level of nitrogen fertilizer, but these increases were not statistically significant ($P>0.05$). The difference in milk yield and SNF % between fertilizer levels became significant ($P<0.01$) from period 3 onwards, while for lactose % it became significant from period 4 onwards (Fig. 1). Butterfat % increased from an average of 3.53% in period 1 to 4.0% in period 5 with no difference ($P>0.05$) between treatments in any period.

Table 1 The effect of level of nitrogen fertilizer on milk yield and milk composition for the whole lactation averaged across two years.

Parameter	Level of nitrogen fertilizer (kg N/ha/year)		Level of significance
	100	300	
Milk yield (kg/cow)	3781	4176	P<0.01
Butterfat %	3.74	3.86	n.s.
Butterfat yield (kg/cow)	140.3	161.2	P<0.01
Solids-not-fat %	8.20	8.36	P<0.01
Solids-not-fat yield (kg/cow)	310.0	349.4	P<0.01
Lactose %	4.70	4.73	n.s.
Lactose yield (kg/cow)	177.5	197.4	P<0.01

Leaf on offer was much higher in the 300 N compared with the 100 N pastures at each sampling (Table 2) and declined in both pastures from summer to late winter. Dietary leaf % in the 100 N groups was lower in autumn and winter, but higher in summer.

Table 2 Leaf content of the pasture and diet at each sampling averaged across two years

	Nitrogen level (kg N/ha/yr)	January	April	August
Leaf on offer (kg DM/ha)	100	997	773	168
	300	1660	1100	428
Leaf in diet (%)	100	63	71	16
	300	56	77	38

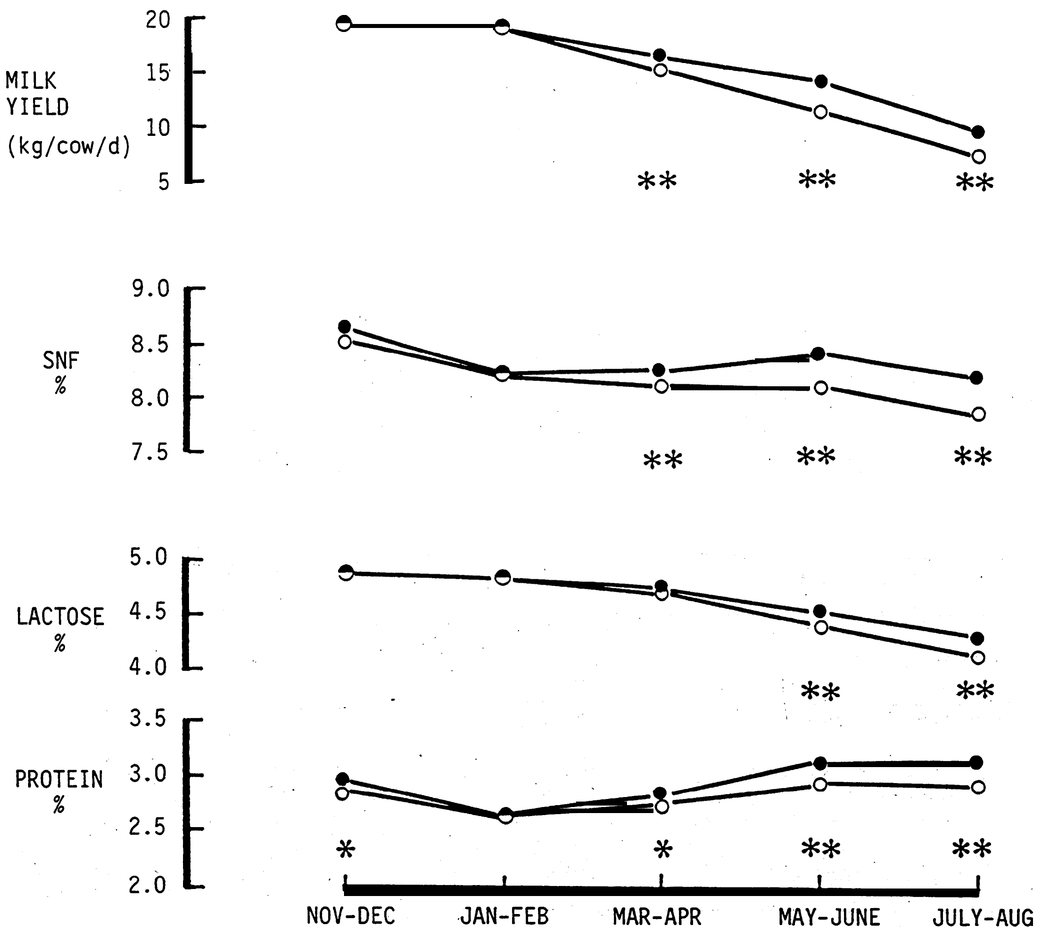

Fig. 1. Milk yield, SNF %, lactose % and protein % (by difference) in each period, averaged across two years for 100 kg N/ha (O) and 300 kg N/ha (●) pastures. Significant differences between treatments are represented by asterisks (P<0.01 **;P<0.05*).

DISCUSSION

The average response in milk yield to nitrogen fertilizer was 5.1 kg milk/kg N over the 2 years. This response is consistent with previous work in this environment (Davison et al. 1985), but may underestimate the full response as cows did not remain in their pastures for the full 12 months. At a milk price of 24 c/kg and a nitrogen cost of 70 c/kg N there is a marginal income of 57 c/kg N applied. Where milk payment or penalties are also based on milk composition then the return on the use of nitrogen fertilizer would be even greater.

Solids-not-fat % is a good indicator of energy intake (Rook and Line 1961) and was consistently higher throughout lactation for cows on 300 N pastures. The difference in SNF % between 300 N and 100 N pastures increased as differences in pasture on offer became more extreme in the dry season. We believe that below 1000 kg DM/ha of leaf on offer, intake of leaf and milk yield will decrease (Davison et al. 1985). This point was reached in April for 100 N pastures and coincided with a decrease in milk yield ($P<0.01$) and SNF % ($P<0.01$) in period 3. The higher leaf content in the diet of 100 N cows during summer reflected the fact that pastures at 100 N were shorter and contained more accessible leaf than those at 300 N. The leaf content of 100 N pastures in summer was 38% compared with 26% for 300 N pastures.

The large decrease in SNF % of milk from all cows during summer (period 2) would be of concern to farmers that calve cows in spring and summer. At 300 N the decrease in SNF % was from 8.63 in period 1 to 8.26 % in period 2. Figure 1 indicates that the decline in SNF % during summer was nearly all due to a decline in milk protein content. The fact that milk yield stayed constant during summer indicates a specific effect of the environment on milk protein content. It is known that for cows fed a constant ration in temperate environments, SNF % will decline until the fifth week of lactation then remain steady until a distinct rise occurs in late lactation (Rook and Campling 1965). In our study the fall continued much later than 5 weeks. Other work in this environment (Davison and Silver 1986) has demonstrated the negative effects on SNF % associated with high ambient temperatures during summer. Higher temperatures are also associated with lower digestibility of herbage (Wilson 1982). The fact that SNF % of milk from cows at 300 N increased during autumn and winter when pasture on offer was declining indicated the effects on SNF % during summer were due as much to environmental effects as stage of lactation. The low SNF levels recorded here even at 300 N, suggest further inputs of energy into the diet are required if farmers are to meet the standard of 8.5% SNF required by milk factories in Queensland.

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