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Optimum white clover content for milk production

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ABSTRACT

Nine Jersey and nine Friesian cows in late lactation and housed indoors were fed diets containing either 20, 50 or 80% white clover with the balance perennial ryegrass. During the first 10 days cows were fed *ad libitum* and during the second 10 days feeding was restricted to 75% of metabolisable energy requirement. Milk yields of cows fed 50% and 80% clover diets *ad libitum* were not significantly different but were 18% greater ($P < 0.05$) than for cows fed 20% clover. During restricted feeding, when intakes were not significantly different, milk yields of cows fed 50 and 80% clover were again not significantly different but were 10% higher ($P < 0.10$) than for cows on 20% clover. Clover content had no effect on milk composition. The experiment indicated increased yields were due mainly to increased intakes associated with high clover diets, and also the higher nutritive value of the clover. Results showed the optimum clover content for milk production was 55-65%.

Keywords: Friesian cow; herbage intake; Jersey cow; milk yield; milksolids; milk composition; nutritive value; perennial ryegrass; white clover.

INTRODUCTION

Previous British (Thomson *et al.*, 1985) and Australian (Rogers *et al.*, 1982; Rogers and Robinson, 1984) research has clearly shown the benefit of pure white clover over pure perennial ryegrass for milk production, particularly in the second half of lactation (Rogers and Robinson, 1984). The higher voluntary intakes of cows eating clover (Rogers *et al.*, 1982) together with the higher nutritive value of clover (Thomson, 1984) contribute to this increased milk production. However, pure clover pastures are unrealistic for NZ dairy farms due to the lower annual dry matter production of pure clover swards (Frame and Newbould, 1984), the higher bloat risk and difficulties in maintaining such swards. In addition there is an energy cost for the cow associated with metabolising high protein (high clover) feeds (Danfaer *et al.*, 1980). Therefore, mixed ryegrass / white clover pasture may prove more advantageous than pure swards providing the clover component is higher than the average 15-20% (Caradus *et al.*, 1996) currently found in dairy pastures. British researchers suggest clover content must be at least 30% to have any significant effect on animal performance (Thomson, 1984). This paper reports on the first in a series of experiments investigating the effect of clover content on milk production with the aim of determining an optimum clover content for NZ dairy pastures.

MATERIALS AND METHODS

The experiment was conducted in April 1996 in the last month of lactation. Nine Jersey and nine Friesian dairy cows, housed indoors and individually stalled, were fed *ad libitum* diets containing either 20, 50 or 80% (of total dry matter (DM)) white clover (three Jersey and three Friesian cows per diet) with the balance perennial ryegrass over a 10

day period. During a second 10 day measurement period one cow of each breed remained on the same clover diet while the other two went to one of each of the other diets. During period 2 all cows were fed a restricted dry matter allowance calculated as 75% of their metabolisable energy (ME) requirement based on the calculation of Holmes and Wilson (1987). Before the experiment all cows were offered the same diet of "typical" dairy pasture for 3 weeks and milk samples collected during this time used for covariate analysis of data.

White clover (*Trifolium repens* cv. Grasslands Kopu) and ryegrass (*Lolium perenne* cv. Yatsyn, high endophyte) were cut twice daily from pure swards and diets mixed by hand. The chemical composition of the herbage was analysed using near-infrared spectroscopy (NIRS) (Ulyatt *et al.*, 1995). Daily herbage intakes of individual cows were calculated by subtracting the dry weight of the refused herbage from the allowance. On *ad libitum* diets cows left approximately 1kg DM at each feeding but there were usually no refusals on the restricted diet. Cows received bloat drench (50mls 1:6 Bloatenz 2in1 (Ecolab Ltd, NZ)) daily. Milk yields were measured over the final 5 days of each measurement period and milk samples collected for composition analysis (fat, protein and lactose) so allowing calculation of milksolids (fat plus protein) yield.

A cross-over model in SAS was used to analyse the data. Pre-trial measurements were used as a covariate, and a breed effect was also included in the model. Linear and quadratic regression analyses of milk and milksolids yield were used to identify optimum clover proportions.

RESULTS AND DISCUSSION

Increased clover content in the diet was associated with higher *in vitro* digestibility, carbohydrate, crude pro-

tein and ME levels and lower fibre levels in the herbage (Table 1). These measures signified an increase in the nutritive value of the diet and usually contribute to increased milk production (Thomson, 1984). In this trial, however, the differences in nutritive value between the three diets were smaller than expected given the wide range in clover content. This was due to the ryegrass component of the diet being of similar chemical composition to the clover.

TABLE 1: Chemical composition (analysed using NIRS) of clover diets, and the pure white clover and pure perennial ryegrass which was cut and mixed to form the diets.

Clover content	20%	50%	80%	pure clover	pure ryegrass
Dry matter (%)	15.5	14.1	13.0	11.6	16.6
Crude protein (g/100g DM)	21.5	22.6	23.8	24.6	20.5
Fibre: ADF ^a (g/100g DM)	27.7	26.3	25.4	23.7	28.4
NDF ^b (g/100g DM)	49.8	45.6	41.2	36.1	52.7
Available carbohydrate ^c (g/100g DM)	8.1	8.7	9.3	9.4	8.0
<i>In vitro</i> digestibility (%)	68.9	70.2	70.9	71.9	68.3
Estimated ME (MJ/kg DM)	10.3	10.5	10.6	10.7	10.2

^a Acid detergent fibre

^b Neutral detergent fibre

^c Readily fermentable carbohydrate

During period 1, when all cows were fed *ad libitum*, daily herbage intakes for cows eating 50 and 80% clover diets were 11% higher ($P < 0.05$) than for 20% clover diets (Table 2). However, there was no significant difference between intakes of cows eating 50 or 80% clover diets. As expected, intakes during period 2 were not significantly different under the different clover levels but were lower than during period 1 due to the restricted diets.

Despite milk production being relatively low, since cows were near the end of lactation, milk yields for cows on 50% clover diets were 18% greater ($P < 0.05$) than yields for cows on 20% clover during period 1 but were only 10% greater ($P < 0.10$) during period 2 (Table 2). During both periods there was no significant difference in yields of cows on 50 and 80% clover. The increase in milk yield during period 1 in response to clover content was due to a combination of higher intakes and increased nutritive value of the diet. Any increase in milk yields during period 2 however could only have been due to the nutritive value of the clover since intakes were similar. However, differences in milk yields were less significant during period 2 suggesting any increase in the nutritive value of the diet associated with higher clover content had a smaller effect on milk production than increases in intake associated with higher clover content. This result was not unexpected given that the diets were very similar in terms of chemical composition and ME (Table 1).

Rogers *et al.*, (1982), comparing diets of pure ryegrass and pure clover, found milk yields of cows eating clover were significantly greater under both *ad libitum* allowance

TABLE 2: Herbage intakes, milk yields and milk composition of cows fed different levels of clover under *ad libitum* or 75% ME requirement (restricted) allowances. Milk yields, milk composition measurements and milksolids yields are adjusted for the covariate period.

Clover content	20%	50%	80%	SED ^a
Intake: <i>ad lib.</i> (kg DM/cow/d)	10.85 ^x	12.15 ^y	12.02 ^y	0.32
Intake : restricted (kg DM/cow/d)	9.08 ^x	9.24 ^x	9.29 ^x	0.31
Milk yield: <i>ad lib.</i> (l /cow/d)	8.48 ^x	9.98 ^y	9.82 ^y	0.27
Milk yield: restricted (l /cow/d)	5.96 ^x	6.55 ^z	6.47 ^z	0.24
Fat %: <i>ad lib.</i>	5.88 ^x	5.73 ^x	5.65 ^x	0.15
Protein %: <i>ad lib.</i>	3.84 ^x	3.76 ^x	3.83 ^x	0.12
Lactose %: <i>ad lib.</i>	4.71 ^x	4.72 ^x	4.69 ^x	0.10
Milksolids yield: <i>ad lib.</i> (kg/cow/d)	0.80 ^x	0.93 ^y	0.93 ^y	0.02

^a Standard error of the difference

^{x, y} Values on the same line with different superscripts are significantly different, $P < 0.05$

^{x, z} Values on the same line with different superscripts are significantly different, $P < 0.10$

(25% greater) and 60% *ad libitum* allowance (13% greater). Thus their results indicated both increased intakes and the higher nutritive value of the clover diet were contributing to the increased milk yields.

Milk composition (fat, protein and lactose %) was not affected by clover content during either period 1 or 2 (Table 2). The increased fat, protein and lactose yields of cows fed 50 and 80% clover diets were directly due to the increased milk yields. Milksolids production, therefore, was significantly greater for cows eating 50 and 80% clover diets than for cows on 20% clover. Rogers *et al.*, (1982) report a similar result for milk composition of cows fed pure clover or pure ryegrass.

Significantly more ($P < 0.05$) ME was used by cows on 20% clover to produce one litre of milk than by cows on either 50 or 80% clover during period 1 (Table 3). However, if maintenance energy requirements (based on calculation of Geenty and Rattray, 1987) were allowed for, there was no significant difference in ME used by cows to produce one litre of milk at any clover level. This suggests increased milk yields at the higher clover levels were associated with increased intakes rather than increased energy conversion efficiencies. Rogers *et al.*, (1982), however, found cows fed pure clover had higher conversion efficiencies than those fed pure ryegrass although it is uncertain whether they allowed for maintenance energy requirements in their calculations.

The results of this experiment indicated an asymptotic or quadratic type response of milk and milksolids yield to clover content in the diet such that cows fed 80% clover had similar intakes, milk and milksolids yields to cows fed 50% clover diets. Plotting both milk yield and milksolids yield against clover content of the diet (% x) gave quadratic type responses viz. milk yield = $-0.00117x^2 + 0.15657x + 5.12926$, $R^2 = 0.4389$; milksolids yield = $-0.00016x^2 + 0.01873x + 0.45305$, $R^2 = 0.398$. Thus this experiment indicated an optimum clover content in the

TABLE 3: Efficiency of conversion of herbage to milk (MJ of ME used to produce 1 (of milk) of cows fed different clover levels at *ad libitum* allowance.

Clover content	20%	50%	80%	SED ^a
Efficiency (MJ ME/1 milk/d)	14.02 ^x	12.43 ^y	12.40 ^y	0.47
Efficiency (excluding maintenance energy requirement) (MJME/1 milk/d)	7.81 ^x	7.59 ^x	7.57 ^x	0.44

^a Standard error of the difference

^{x,y} Values on the same line with different superscripts are significantly different, P<0.05

diet for milk yield of 66%, and 59% for milksolids yield. Further outdoor grazing trials are necessary however before an optimum clover content for NZ dairy pastures can be determined, since the effect of clover content on total herbage production, as well as milk production, must be taken into account.

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