Effect of feeding turnips to dairy cows grazing limited amounts of pasture in mid to late lactation on milksolids production

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ABSTRACT

Three groups of 20 cows were allocated to one of three feeding treatments. A control group was offered only a restricted pasture allowance. Treatments groups were offered pasture and turnips at either 4 or 8 kg DM/cow/day. Cows offered 4 kg DM/cow and 8 kg DM/cow of turnips produced 265 g MS/c/day (± 24g) and 305 g MS/c/day (± 24g) more than cows offered pasture only. The milksolids production of cows offered 8 kg DM/cow was not higher ($P<0.05$) than cows offered 4 kg DM as turnips. No difference ($P<0.05$) in liveweight or condition score was measured between treatment groups.

In a second trial, three groups of 10 cows were offered 8 kg DM/cow of turnip. Treatments were turnips plus 10 kg pasture dry matter intake (DMI); turnips plus 7 kg pasture DMI and 3 kg DM of pasture silage; and turnips, 4 kg pasture DMI and 6 kg DM of pasture silage. Nutritional treatments did not increase ($P<0.05$) milksolids production, liveweight or conditions score, however, the high silage allowance reduced ($P<0.05$) animal performance.

Keywords: turnips; summer; milk production; liveweight, substitution.

INTRODUCTION

The viability of the New Zealand Dairy Industry is reliant on pasture as a low cost source of feed. High output of milksolids (MS) per ha is achieved by maximising pasture production, and using high stocking rates, and seasonal calving to ensure a large proportion of the available pasture is consumed by lactating dairy cows. However, relying on pasture as almost the only source of feed exposes the production system to the weakness of a feed base inherently variable in supply and nutritional characteristics. In many dairying districts summer moisture stress causes feed deficits and poor pasture quality. This contributes to typically short lactations and poor late season milk yields, resulting in 75% of total annual milksolids production being produced in the first 175 days of lactation (Macmillan and Hederson 1987).

In recent years dairy farmers have made increasing use of turnips as a fast growing, high quality source of summer forage. Large areas in the Waikato, Northland, Taranaki and the lower North Island are now being planted annually. Clark *et al.*, (1996) reported from a survey of the 1994-95 season that the average turnip crop yield achieved on New Zealand dairy farms was only 7.4 t DM/ha, with a range of 0 - 15.2 t DM/ha. Simple calculations based on the average DM production of the crop, and the opportunity cost of lost pasture growth, suggest that in most situations turnips will not result in profitable increases in milk production. However, the importance of a high quality source of feed, available when pasture quality is low, may be under estimated by such calculations.

The aim of this work was to determine the effect of offering turnips to cows grazing restricted amounts of pasture in summer on milksolids production, cow condition, cow liveweight, and pasture substitution. A second trial was established to determine the effect on milksolids production of offering different proportions of pasture and pasture silage at a high turnip allowance.

MATERIALS AND METHODS

A 1.75 ha crop of Barkant turnips was established a the DRC No 1 Dairy on 30 November 1994. Seed was precision drilled at 1.8 kg/ha after cultivation and application of 500 kg/ha of borated 30% potassic super phosphate. Urea was applied to the crop at 46 kg N/ha, 23 days after sowing. This area was used over a 9 week period in two short term feeding trials.

Experiment 1

Three herds of 20 spring calving cows were established in February 1995. Each herd was balanced for age, genetic merit, current milksolids production and cow condition and liveweight. All cows were grazed together and offered a daily pasture allowance of 40 kg DM/cow for a uniformity period of 1 week from 29 January 1995. Following the uniformity period, experimental groups were grazed separately. Each group was offered a daily pasture allowance of 23 kg DM/cow for 5 weeks. Experimental groups were allocated to a turnip allowance of either 0, 4, or 8 kg Turnip DM/cow/day grazed *in situ* between the AM and PM milkings. To familiarise cows to turnips, allowances were gradually increased from 6 February to the full allowance by 19 February. Milk yield and composition was measured by weekly herd test throughout the trial, and is reported for the final three weeks from 20 February to 12 March. Liveweight and cow condition was measured on two consecutive days at the conclusion of the uniformity

period, and at the conclusion of the experimental period.

Experiment 2.

Immediately following experiment 1, 30 late lactation cows which had previously eaten turnips were allocated to three treatment groups balanced for age, genetic merit, current milksolids production, cow condition and liveweight, and previous treatment. All groups were offered a turnip allowance of 8 kg Turnip DM/cow/day *in situ* between the AM and PM milkings for three weeks from 13 March 1995. Each group was allocated to one of three feeding treatments: turnips plus 10 kg pasture DMI/cow; turnips plus 7 kg DMI/cow pasture and 3 kg DM/cow as pasture silage; turnips plus 4 kg DMI/cow pasture and 6 kg DM/cow as pasture silage. The required pasture DMI was achieved by adjusting pasture allowance. Silage was offered daily at approximately 10 AM in the turnip area being grazed. Milksolids production is reported as the mean for the three weeks during feeding treatments. Liveweight and cow conditions was measured on two consecutive days immediately before the trial commenced and on the final two days of the experimental period.

Feed Quality Measurements

During each experiment, weekly feed samples were taken from pasture to be grazed by each herd for the following four days by hand clipping to grazing height and turnip samples were taken by randomly pulling plants from the area to be grazed in the following week. Feed samples were analysed for *in vitro* digestibility, NDF, and total nitrogen. Pasture intake was estimated by difference based on pre- and post grazing herbage mass as assessed by calibrated visual assessment.

Statistical analysis

The mean milk production, liveweight, and condition score data from experiment 1 were analysed by covariate analysis and analysis of variance. In experiment 2, raw production data and covariate adjusted liveweight and condition score data were analysed by analysis of variance. Feed intake and chemical composition data are expressed as means.

RESULTS

Total rain fall from 1 December 1994 to 31 March 1995 was 323 mm compared to the 10 year average for the same period of 380 mm. Soil moisture deficits occurred in December and January when rainfall less evopotranspiration created deficits of 170 mm and 80 mm respectively. By early February good rainfall in late January resulted in fresh green leafy pasture of high digestibility and crude protein content (Table 1).

Experiment 1

Feed intake, and animal performance data is contained in Table 2. Increasing turnip allowance resulted in little pasture substitution. Offering 3.9 kg DM/cow as turnips reduced daily pasture intake by 0.8 kg DM/cow and 8.5 kg DM/cow as turnip reduced pasture intake by 1.3 kg DM/cow representing a mean substitution rate of 0.2 kg DM/kg Turnip allowance. Offering 3.9 kg DM/cow as turnips increased milkfat and protein production by 34% and 40% respectively. Increasing turnip allowance from 3.9 to 8.5 kg DM/cow resulted in no extra milkfat production, but increased milk protein production by 7%. At the conclusion of the experimental period the liveweight of cows offered turnips was significantly higher than those offered no turnips, however no difference in cow condition was measured.

TABLE 1: Dry matter (DM) crude protein (CP) organic matter digestibility (OMD) neutral detergent fibre, phosphate (P) and calcium (Ca) content of pasture, turnip leaf and stem, turnip bulbs, and total weighted turnip means for Experiment 1.

	DM %	CP %	OMD %	NDF %	P %	Ca %
Pasture	18.5	24.4	78.8	54.3	0.35	1.3
Turnip top	7.0	16.0	81.5	31.2	0.44	1.65
Turnip bulb	8.6	10.0	85.8	26.0	0.38	1.44
Turnip	7.5	14.2	82.0	29.6	0.42	1.58

TABLE 2: Mean daily pasture allowance and intake, turnip allowance, and milk production data for the three week measurement period, and liveweight and cow condition at the conclusion of experiment 1.

Treatment	0	4	8	SED
Pasture allowance (Kg DM/cow)	23	23	23	
Pasture intake (Kg DM/cow)	10.0	9.2	8.7	
Turnip allowance (kg DM/cow)	0	3.9	8.5	
Milk yield (kg/cow)	8.44^a	11.63^b	12.12^b	0.259
Milkfat yield	0.44^a	0.59^b	0.61^b	0.016
Milk protein yield	0.30^a	0.42^b	0.45^c	0.009
Liveweight	403^a	418^b	421^b	2.7
Cow condition	4.3^a	4.2^a	4.3^a	0.09

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

Experiment 2.

The chemical composition of the pasture and turnips used in experiment 2 is shown in Table 3. If it is assumed that 80% of both the turnips and silage was utilised, the total DMI of each of the treatment groups was similar (Table 4). Offering 3 or 6 kg DM/cow as silage and reducing the pasture DMI to 6.0 and 4.2 kg/cow respectively did not effect milk, milkfat, or milk protein yield relative to cows offered no silage. However, cows offered 3 kg DM/cow as silage produced 24% and 23% more ($P>0.05$) milkfat and protein than cows offered 6 kg DM/cow as silage. At the conclusion of the trial the average liveweight of cows offered 6 kg DM of silage was significantly heavier than cows offered either no silage, or 3 kg DM of silage.

DISCUSSION

The immediate response of an extra 69 g MS/kg DM when turnips were offered at 3.9 kg DM is high relative to milk production responses that have been measured when other supplements have been offered through the summer

TABLE 3: Dry matter (DM) crude protein (CP) organic matter digestibility (OMD) neutral detergent fibre, phosphate (P), and calcium (Ca) content of pasture, pasture silage, turnip leaf and stem, turnip bulbs, and total weighted turnip means for Experiment 2.

	DM %	CP %	OMD %	NDF %	P %	Ca %
Pasture	18.3	22.2	74.7	53.8	0.32	0.58
Silage	37.6	13.8	70.0	55.7		
Turnip top	7.1	12.2	80.2	30.0	0.30	2.59
Turnip bulb	8.7	9.36	84.8	26.3	0.34	0.79
Turnip	8.2	11.2	81.9	28.7	0.31	1.92

TABLE 4: Mean daily pasture allowance and intake, silage allowance, turnip allowance, mean milk production data for the three week trial period, and liveweight and cow condition at the conclusion of experiment 2.

Treatment	0	3 silage	6 Silage	SED
Pasture allowance (kg DM/cow)	25	15	10	
Pasture intake (kg DM/cow)	8.5	6.0	4.2	
Silage allowance (kg DM/cow)	0	3	6	
Turnip allowance (kg DM/cow)	8	8	8	
Milk yield (kg/cow)	10.5^{a}	11.3^{a}	10.0^{a}	0.66
Milkfat yield	0.51^{ab}	0.56^{a}	0.45^{b}	0.042
Milk protein yield	0.40^{ab}	0.43^{a}	0.35^{b}	0.028
Liveweight	413^{a}	413^{a}	419^{b}	2.4
Cow condition	4.3^{a}	4.3^{a}	4.4^{a}	0.10

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

period. Bryant (1989) reported typical responses to the use of summer supplements as 25 g MS/kg DM. At the higher turnip allowance, the lack of an incremental increase in animal performance reduced the response to 37g MS/kg DM. These responses agree with those reported by Clark *et al.*, (1996) where offering mid lactation cows turnips at 5 kg DM/cow resulted in a response of 36 g MS/kg DM.

The milksolids response obtained in this experiment, and that reported by Clark *et al.*, (1996), are substantially lower than the response of 100 g MS/kg DM assumed by Notman (1992), however, this work and that of Clark *et al.*, (1996) only measured immediate responses. After the conclusion of the feeding period extra milk may be produced as a result of improved cow condition, or from extra herbage mass resulting from pasture substitution. When supplementary feed is offered, the carry-over effect on milksolids production is typically equal to, or greater than the immediate effect. Clark (1993) found that when silage was fed in the summer, an and extra 16g MS/kg DM was measured during the feeding period, but by the end of the season an additional 50 g MS/kg DM had been produced, resulting in a total response of 66 g MS/kg DM.

In this trial, the carry over effects are likely to be minimal. In the example of Clark (1993) the carry over effect was attributed to slightly better cow condition, and more importantly, an extra 380 kg DM/ha herbage mass at the end of the silage feeding period. Given the mean substitution rate measured in this trial of 0.2 kg DM/kg DM, feeding 6 kg DM/cow as turnips for 30 days at a stocking rate of 3 cow/ha would increase average farm herbage mass by only 108 kg DM/ha. Furthermore the difference in liveweight at the end of the experiment was small, and there was no difference in cow condition.

The lack of an incremental response at the high turnip allowance may indicate that the nutrition provided by the combination of turnips and pasture is inadequate to sustain high levels of animal performance in mid to late lactation. The nutritional value of the pasture used during these experiment was better than would be available under drier summer conditions. The fact that the addition of silage did not result in improved animal performance may indicate that the problem was not due to the low fibre content of the total diet as initially suspected. In experiment 2 the crude protein content of the silage was only 13.8%. Given the respective intakes of pasture, silage and turnips, the average crude protein content of the total diet of cows in experiment 2 was 16.5%, 15.5% and 14.5% for cows offered 0, 3, and 6 kg DM/cow silage respectively. The lower performance of cows offered 6 kg DM/cow silage may be attributable to the low crude protein content of the total diet, given that the minimum crude protein content required by late lactation cows grazing high quality diets is 14.5% - 15.5% DM (Holmes *et al.*, 1984). The low crude protein content of turnips, particularly as they reach maturity (Table 3), may restrict the performance of dairy cattle when they are grazing dry summer pasture which has a crude protein content of only 10 - 15% (Holmes *et al.*, 1984).

CONCLUSION

Turnips are a fast growing forage crop of high nutritional value. Offering a moderate allowance (4 - 5 kg DM/cow) of turnips to cows grazing restricted amounts of pasture in summer will result in good immediate MS responses, little pasture substitution, and little change in cow condition. Results from these trials indicate that offering a higher allowance of turnips is unlikely to increase animal performance. At higher allowances the nutritional characteristics of turnips may limit animal performance, although these have not been identified.

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REFERENCES

Bryant, A.M. 1989. Altering the seasonality of milk production. *Proceedings of the Ruakura Farmers Conference:* **41:** 60-65

Clark, D.A. 1993. Silage for milk production. *Proceedings of the Ruakura Farmers Conference,* **45:** 41-46

Clark, D.A.; Howse, S.; Johnson, R.J.; Pearson, A.; Penno, J.W.; Thomson, N.A. 1996. Turnips for summer milk production. *Proceedings of the New Zealand Grasslands Association* **57:** 145 - 150

Holmes, C.W.; Wilson, G.F; Mackenzie, D.D.S; Flux, D.S.; Brookes, I.M.; Davey, A.W.F. 1984. Milk production from pasture. Ed C.W. Holmes and G.F. Wilson. Butterworths. New Zealand.

Macmillan, K.L; Henderson, H.V. 1987: Trends in monthly milkfat production of cows in seasonal dairy herds in New Zealand. *Proceedings of the New Zealand Society of Animal Production* **47:** 57-59

Notman, P. 1992. Survey of turnip yield in Victoria, Australia. DRDC report.