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EFFECT OF HERBAGE ALLOWANCE ON DAIRY COW PERFORMANCE

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SUMMARY

One of four groups of 15 cows was offered an area of pasture each day to provide a herbage allowance of approximately 50 kg DM/cow, while the other groups were offered 75, 50 or 25% of this area. Treatments were applied in three experiments for 28 d in early and mid lactation and 21 d in late lactation beginning 31, 94 and 189 d after calving. In each experiment the yield of milk, fat, protein and lactose, liveweight change, herbage intake and herbage mass following grazing decreased as allowance was reduced. The response in milk composition varied between experiments.

The regression coefficient relating DOM intake and yield of FCM did not differ between experiments and indicated that 1 kg increase in FCM required an increase in DOM intake of 0.54 kg, implying that 1 kg increase in milkfat and milk solids required 13.5 and 4.5 kg DOM, respectively. This relationship, together with the reduction in percentage utilization of pasture as herbage allowance increased, meant that production per hectare of milk and its constituents declined much more than production per cow increased.

INTRODUCTION

Herbage allowance is an important determinant of the performance of grazing sheep (Rattray and Jagusch, 1978; Jagusch *et al.*, 1979), steers (Reardon, 1975; Trigg and Marsh, 1979), and lactating dairy cattle (see Hodgson, 1976; Combellas and Hodgson, 1979).

Quantitative information on the relationship between herbage allowance and animal performance is essential for understanding the efficient conversion of grazed pasture into animal product. In some instances (Hodgson, 1976; Rattray and Jagusch, 1978; Trigg and Marsh, 1979) the relationship between daily allowance and performance is strongly curvilinear, with increments in herbage allowances resulting in successively smaller increments in intake or performance so that substantial changes in allowance at the upper end of the curve have little effect on performance. Where this occurs there is considerable scope for adopting grazing management that is a sensible compromise between high animal performance and efficient pasture utilization. Whether this applies in the case of lactating dairy cows is not known since insufficient data are available to establish the nature of the relationship between milk production and herbage allowance. This is so even though the rotational grazing practices common to dairying provide more opportunity for manipulating herbage allowance than management based on set stocking.

This paper summarizes the effects of contrasting herbage allowances on cow performance in early, mid and late lactation during the 1976-7 season. The treatments were of short duration to avoid confounding results with any cumulative effects on pastures or animals.

EXPERIMENTAL

Each of three experiments involved 30 sets of identical twins divided according to an incomplete block arrangement among four treatments. Cows in treatment 1 were offered an area of pasture each day to provide a herbage allowance of approximately 50 kg DM/cow/day. Cows in the other treatments were offered each day 75, 50 or 25% of this area (treatments 2, 3 and 4, respectively). The experiments were in early (22 September—19 October, Exp. E), mid (24 November—21 December, Exp. M), and late (2—22 March, Exp. L) lactation. At other times all cows were provided with generous grazing. The pasture was a mixture of ryegrass, white clover and paspalum and had been grazed by dairy cows for many years previously.

Initial liveweights were 367, 388 and 373 kg for Experiments E, M, and L, respectively, whereas days in milk were 31, 94 and 189 days. The same cows were not necessarily used in each experiment.

Appropriate areas of pasture of uniform herbage mass prior to grazing were offered to the treatment groups following morning milking. For each treatment, pre- and post-grazing mass was estimated on the areas grazed on Tuesday, Wednesday and Thursday of each week. Dry matter (DM) enclosed within a quadrat (0.33 m^2) when randomly placed at a frequency of about 200 positions per hectare was estimated visually. DM yield represented by the mean visual estimate for each treatment was predicted from the relationship between visual estimate and DM yield, established when the herbage enclosed in the quadrat at 20 sites (five per treatment) was visually assessed, then cut to ground level, washed, dried and weighed. Separate pre- and post-grazing relationships were established for each day.

Milk yield was measured at each milking (0700 and 1600 h). Composition was determined by infrared analysis each Wednesday and Friday on samples bulked over the previous four milkings.

Cows were weighed on four consecutive mornings at the start and end of each experiment. Prior to the fourth weighing, cows were held in concrete yards for 16 h without food or water.

Pasture intake by individual cows was measured by the chromium oxide *in vitro* digestibility technique. A gelatine capsule containing 10 g chromium oxide suspended in oil was administered to each cow at each milking. Faeces were taken from the rectum at each milking, dried, and 2.5 g portions bulked over 7 d. *In vitro* digestibility was determined on pasture clipped to grazing height from two exclosure cages per treatment group on 5 d each week.

Effects of treatments on yield of milk and its constituents and on milk composition were assessed by covariance analysis using data during 7 to 14 d preceding each experiment as covariates. Data from the first 7 d of each experiment were excluded from the analysis.

RESULTS

Herbage mass before grazing was similar within and between experiments (Table 1). So also were herbage allowances within treatments between experiments. Post-grazing herbage mass declined with decreasing herbage allowance in each experiment, whereas it tended to increase within treatments as lactation advanced, particularly at the lowest herbage allowance. Converse changes occurred in percentage utilization of herbage. Whereas in all experiments, reduction in herbage allowance decreased milk yield, effects on milk composition depended on stage of lactation (Table 2). Thus as herbage allowance decreased, percentage of fat decreased in Exp. E, was not significantly affected in Exp. M, and increased in Exp. L, Protein percentage decreased in Exp. E and M but increased in Exp. L, whereas lactose percentage decreased in all three experiments.

The curvilinear component of the relationship between herbage allowance and yield was not significant for milk, fat, protein or lactose in Exp. E but was in every instance in Exp. M and L. The relationship tended to increase in curvilinearity as lactation advanced, illustrated for the combined yield of fat, protein and lactose in Fig. 1. Although yield per cow increased with increas-

TABLE 1: HERBAGE MASS BEFORE AND AFTER GRAZING, PERCENTAGE UTILIZED AND DAILY ALLOWANCE

	Treatments 1	2	3	4	*SE*
Exp. E					
Herbage mass (kg DM/ha)					
Before	3 133	3 194	3 124	3 057	52
After	2 394	2 252	2 008	919	57
Utilization (%)	24	29	36	70	1.7
Allowance (kg DM/cow)	52	40	26	13	0.7
Exp. M					
Herbage mass (kg DM/ha)					
Before	3 231	3 309	3 241	3 181	37
After	2 596	2 412	2 112	1 284	63
Utilization (%)	20	27	34	59	1.8
Allowance (kg DM/cow)	54	41	27	13	0.7
Exp. L					
Herbage mass (kg DM/ha)					
Before	3 109	3 236	3 201	3 235	61
After	2 410	2 478	2 070	1 783	80
Utilization (%)	22	23	35	44	2.3
Allowance (kg DM/cow)	52	40	27	14	1.1

ing herbage allowance, production per hectare decreased. Thus the combined yield of fat, protein and lactose in Exp. E was 140, 182, 242 and 444 kg/ha/day for treatments 1 to 4, respectively. Equivalent yields for Exp. M were 120, 155, 205 and 341, and for Exp. L they were 75, 95, 128 and 185 kg/ha/day.

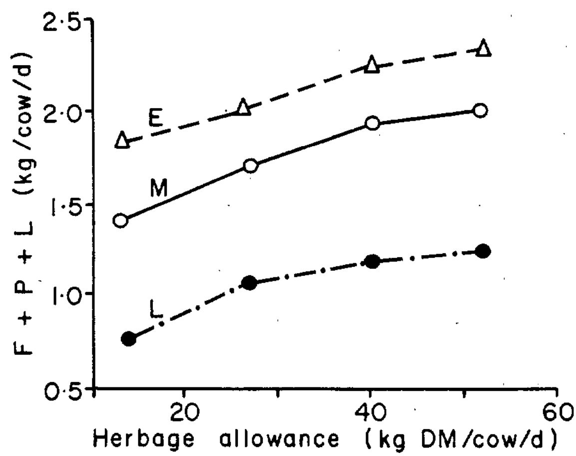

FIG. 1: *Effect of daily allowance on combined daily yield of fat (F), protein (P) and lactose (L).*

TABLE 2: EFFECT OF HERBAGE ALLOWANCE ON YIELD OF MILK AND ITS COMPOSITION

	Exp.	Treatments 1	2	3	4	SED	Signif. of Contrasts Linear	Quadratic
Milk	E	127.0	124.8	113.6	104.0	4.25	***	n.s.
(kg/cow/7 d)	M	108.3	106.2	94.2	79.4	2.54	***	**
	L	66.3	62.3	55.6	39.8	1.48	***	***
	E	4.51	4.33	4.31	4.33	0.070	*	*
Fat (%)	M	4.42	4.47	4.48	4.42	0.082	n.s.	n.s.
	L	4.90	5.09	5.20	5.45	0.090	***	n.s.
	E	3.43	3.41	3.31	3.20	0.039	***	n.s.
Protein (%)	M	3.51	3.46	3.42	3.25	0.017	***	***
	L	3.63	3.69	3.70	3.76	0.042	**	n.s.
	E	5.03	5.05	4.99	4.98	0.024	*	n.s.
Lactose (%)	M	5.02	5.02	5.00	4.96	0.016	***	n.s.
	L	4.78	4.75	4.74	4.60	0.032	***	*

TABLE 3: CHANGE IN FASTED LIVEWEIGHT (kg/cow/day)

	Treatments					Signif. of Contrasts	
Exp.	*1*	*2*	*3*	*4*	*SED*	*Linear*	*Quadratic*
E	0.29	0.70	0.25	–0.14	0.17	***	**
M	0.35	0.35	0.09	–0.15	0.12	***	n.s.
L	0.67	0.90	0.63	0.12	0.15	***	**

Fasted liveweight gain was consistently at a maximum for treatment 2 (Table 3), with gains being the highest in Exp. L and the lowest in Exp. M. The relationships between intake of digestible organic matter (DOM) and herbage allowance (Fig. 2) were similar to those for milk solids and herbage allowance (Fig. 1) except that, in contrast to the latter, DOM intake was higher in Exp. M than in Exp. E. Fat corrected milk (FCM, kg/cow/week) was related to DOM intake (kg/cow/week) according to the equation

$$\text{FCM/kg LW}^{0.75} = \left.\begin{matrix}\text{E}\\\text{M}\\\text{L}\end{matrix}\right\} + 1.85 \pm 0.134 \ \ \text{DOM/kg LW}^{0.75}$$

$$(r = 0.88)$$

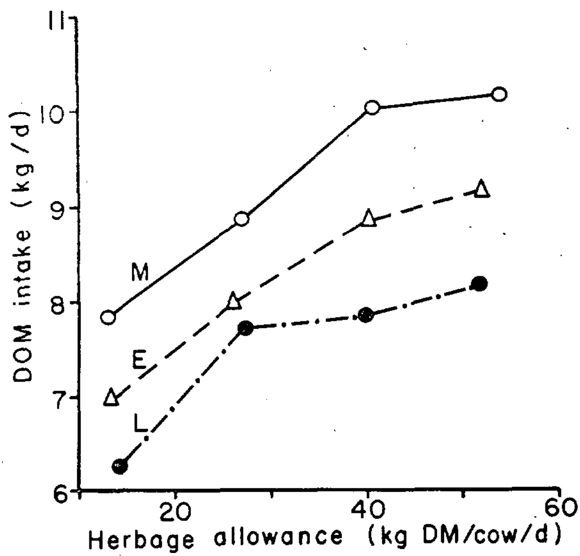

FIG. 2: *Effect of daily allowance on DOM intake. SE of differences 0.21 and 0.37 within and between experiments, respectively.*

The intercepts, but not the coefficients, differed significantly between experiments. The low correlation of liveweight gain and DOM intake ($r = 0.30$) and between gain and FCM ($r = 0.01$) increases confidence in the interpretation that, irrespective of stage of lactation, FCM/cow increased by 1.85 kg per kilogram increase in DOM intake. Since digestibility of OM was 78, 74 and 69% in Exp. E. M and L, respectively, at 1 kg increase in FCM yield required 0.78, 0.82 and 0.87 kg DM. Alternatively, the increase in milkfat yield per cow due to an increase in level of feeding was at the rate of approximately 1 kg fat/21 kg DM. For milk solids (F+P+L) the rate was 1 kg solids/7kg DM.

DISCUSSION

The data reported here demonstrate that the performance of grazing dairy cattle was reduced as daily herbage allowance decreased. This was so for the yield of milk and its constituents, liveweight gain, and pasture intake at each of the three stages of lactation examined. There were also clear responses in milk composition. These differed between experiments and have been referred to elsewhere (Bryant, 1979).

Although cow performance increased with increasing allowance, so also did post-grazing herbage mass. Undoubtedly, a stage is reached where mass remaining after grazing attains a level that is agronomically unsound because of consequences on factors like photosynthetic efficiency, sward density and tiller production. It may also be speculated that while high post-grazing mass ensures a generous herbage allowance at subsequent grazings, nutritive value of this may be reduced to the extent that cow performance also declines.

Of greater practical significance is the relationship between per-cow and per-hectare production as herbage allowance varied. The data clearly show that the increase in yield per cow of milk and its constituents as herbage allowance increased was of much smaller magnitude than the decrease in the yield of these per hectare. Thus an increase in daily allowance from approximately 25 kg DM in treatment 3 to 40 kg DM in treatment 2 increased per-cow yield of milk solids by 0.12 to 0.25 kg/day, whereas production per hectare was reduced by 35 to 60 kg/day. This reduction per hectare arises not only from a decrease in percentage of DM/ha harvested but also from the large increase in pasture intake necessary to induce unit increase in per-cow yield of FCM, fat or milk solids.

Clearly, a compromise is necessary between the conflicting herbage allowances required for high animal performance and realistic yields of both DM following grazing and milk solids per hectare. The extent that there is a compromise in practice is indicated in Table 4. This gives the herbage allowances which prevailed in the experiment described by Bryant and Parker (1971) during the months corresponding to when the present experiments were done. Each farm consisted of twenty-four 0.24 ha paddocks. Intervals of 12 and 24 days between grazings were achieved by offering a fresh paddock after each milking or, as in the present experiments, after the morning milking. The daily herbage allowances that resulted contrast with the 50, 40 and 30 kg DM/cow in Exp. E, M and L, respectively, associated with about maximum yield of milk solids per cow.

TABLE 4: HERBAGE ALLOWANCE AND YIELD OF MILKFAT ON EXPERIMENTAL FARMLETS STOCKED AT 4.12 COWS/HA

	Days Between Grazings	*Month*		
		Oct.	*Dec.*	*Mar.*
Allowance	12	49	55	49
(kg/cow/day)	24	28	32	25
Fat yield	12	0.70	0.59	0.33
(kg DM/day)	24	0.69	0.53	0.30

Table 4 also shows that the relationship between herbage allowance and cow performance, as indicated by milkfat yield per cow, differed for the two grazing intervals. This emphasizes that animal performance is affected by a number of sward characteristics other than herbage allowance. These are likely to include weight of herbage present, its feeding value, sward structure and botanical composition. Interactions between these factors and between them and herbage allowance are probable. It is also stressed that the influences of current herbage allowance on the subsequent performance of both pastures and the animals grazing them are largely unknown.

Concentration of research effort on the easily measured factor of herbage allowance is unlikely to be profitable. Rather, progress in achieving improvements to our systems of converting grazed pasture into animal products requires study of all sward characteristics determining animal performance. Research of this type requires agronomists, animal nutritionists and others to be working in co-operation, rather than in isolation.

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