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INFLUENCE OF VEGETATION PATCH CHARACTERISTICS ON DISCRIMINATORY GRAZING BY DAIRY COWS

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ABSTRACT

Two studies involving the sequential grazing of sets of patches on a perennial ryegrass *(Lolium perenne)* sward were carried out to investigate the effects of patch characteristics on the selective behaviour of grazing cattle. Experiment 1 involved a range of combinations of sward height (8.9 - 19.6 cm) and bulk density (1.33 - 1.67 mg DM/cm^3). Distribution of grazing activity (number of bites or residence time) was strongly and positively related to patch height, but additional effects of variation in bulk density were limited. In Experiment 2 patches were manipulated to offer contrasts in both height (13.4 and 21.8 cm) and maturity (leaf to stem ratio, 2.53 and 0.74). In this case animals concentrated grazing bites and time on the shorter, more leafy patches. Behaviour at a patch was not significantly affected by the characteristics of the preceding or the succeeding patch in either study. These results indicate that under short term observations decision rules are largely influenced by the factors influencing ease of ingestion of herbage.

KEYWORDS

Selective behaviour, sward height, bulk density, maturity, grazing bites, residence time

INTRODUCTION

There is now considerable evidence on the mechanisms determining bite weight and their subsequent influence on herbage intake (Black and Kenney, 1984). Further fine-tuning of grazing management strategies will therefore be a direct result of a greater understanding of foraging behaviour (Stuth, 1991; Gordon and Lascano, 1993). Grazing cattle are continually faced with decisions on selective defoliation, with the complexity of those decisions determined by the level of sward heterogeneity (Gordon and Lascano, 1993). This paper reports on results from 2 studies investigating the influence of sward characteristics on patch grazing decisions using a controlled technique based on the procedures originally used to test optimal foraging theory by Laca et al. (1993).

METHODS

Two studies were conducted at Massey University, New Zealand over late summer/early autumn and spring, 1995. Experiment 1 involved combinations of sward height and bulk density at a patch scale, and Experiment 2 a contrast in pre-grazing management superimposed on contrasting patch areas. The sets of patch treatment combinations were established in strips of perennial ryegrass pasture (cv. Agriseeds Yatsyn) and structured in linear series, with replication of each series over a sequence of patches. Individual patches of 0.88*0.90m were defined by 0.45m marginal strips mown to c. 2cm in 2m wide grazing "walkways".

In Experiment 1 there were 9 treatment combinations involving 5 levels of sward height (H) and 3 levels of bulk density (D) created by preliminary cutting treatments (Table 1). The sets of 9 H*D combinations were replicated 3 times within each sequence, and 4 sequences were used. For Experiment 2, two levels of sward height and maturity were established by repeated cutting to either 5cm or 14cm, followed by a 2 week period of regrowth before grazing, and half of the tall patches were reduced in area to 0.44*0.90m (Table 2). Treatments were replicated 6 times within each of 2 sequences, which were themselves duplicated.

Four mature cows were used in each study, after preliminary training, each cow grazing one of the sequences of patches at one time with their movement confined by electric fencing. Grazing decisions were defined in terms of residence time (sec) and grazing bites per patch. Sward surface height per patch was measured using a sward stick (Barthram, 1986) before and after grazing. Herbage removed was estimated from direct estimates of herbage mass before and after grazing, and regression relationships between sward height and capacitance probe readings, for experiments 1 and 2 respectively. Data was analysed using the statistical package Minitab (Minitab, 1995) fitting effects of sequences, blocks within sequences, treatments, and previous and succeeding patch conditions.

RESULTS AND DISCUSSION

In Experiment 1, variations in density were smaller than contrasts in height (Table 1). Animals regularly sampled from all but the shortest of swards, increasing the number of bites removed (0-54 $\pm$ 1.63 $P<0.001$) and residence time per patch (0-55 $\pm$ 1.56 sec $P<0.001$) as sward height progressively increased from 8.9 - 19.6 cm (Table 1). There was evidence of asymptotic relationships between sward height and both bite number and residence time (Table 1). Sward height exerted the major impact on behavioural responses($P<0.001$), with bulk density having very limited additional effects. Greater control of herbage mass and bulk density between patches would be required to assess the effect of trade-offs on grazing decisions.

In Experiment 2, the two sward types had similar height distribution of regrowth (c. 8cm) on different heights of mature material (5cm and 14cm). The regrowth of tall mature swards was characterised by greater shear strength (54N vs 87N$\pm$ 3.5 $P<0.001$ for sets of 5 tillers) and lower leaf to stem ratios (2.53 vs 0.74$\pm$ 0.004 P(0.002) than the short immature swards. Whole sward estimates of OM digestibility and crude protein were (63.8% vs 61.7% $\pm$ 0.58 $P=0.234$) and (11.6% vs 8.0% $\pm$ 0.26 $P=0.064$) respectively for the two sward types. Cows exercised deliberate choice for short, immature swards by removing more bites ($P<0.001$) and increasing residence time ($P<0.001$) compared to tall mature swards (Table 2). A separate analysis for the mature swards indicated that the effect of patch area was significant (P(0.002) for both bite number and residence time.

In Experiment 1, the distribution of grazing behaviour was directly related to sward height (Table 1). In Experiment 2, however, animals preferred to graze the shorter swards with greater leaf content and lower shear strength despite the limited contrast in digestibility. In this case, the increased proportion of reproductive stem would have acted as a barrier to penetration (McRandal and McNulty, 1980) and made selection of leafy material difficult (Demment and Laca, 1993). Ease of eating has been identified by Black (1990) to be an important criterion in selection of food patches. The contrasts in responses between these studies reinforce the argument that tactile cues relating to the factors influencing ease of handling largely control grazing decisions on a short term basis. However, unreliable estimates of herbage removed precluded estimates of rate of intake in these studies.

In both experiments there was a strong positive correlation between grazing bites and residence time per patch (r=0.987 and r=0.995 respectively). These results contradict the suggestion by de Vries and Daleboudt (1994) that grazing bites provides a poor criterion for examining patch selection. Animals consistently sampled all patches in Experiment 1, supporting suggestions by Illius and Gordon (1990) that animals have poor information uptake and retention. In Experiment 2 animals appeared to be less inclined to sample, walking further for greater rewards, in accord with the discussion of de Vries and Daleboudt (1994) that in an environment with greater contrasts between patches, selectivity will be less dependent upon sampling. In both studies, analysis of sequence effects indicated that behaviour on the current patch was not significantly affected by conditions on either the preceding or the succeeding patch, in contrast to the expectations of optimal foraging theory (Laca et al., 1993).

REFERENCES

Barthram, G.T. 1986. Experimental techniques: The HFRO sward stick. Biennial Report 1984-1985, Hill Farming Research Organisation, Penicuik. pp 29-30.

Black, J.L. 1990. Nutrition of the grazing ruminant. Proceedings of the New Zealand Society of Animal Production **50**: 7-27.

Black, J.L. and **P.A. Kenney**. 1984. Factors affecting diet selection by sheep II. Height and density of pastures. Australian Journal of Agricultural Research **35**: 565-578.

Demment, M.W. and **E.A. Laca.** 1993. The grazing ruminant:Models and experimental techniques to relate sward structure and intake. World Conference on Animal Production, Edmonton, Canada, p.439-460.

Gordon, I.G. and **C. Lascano.** 1993. Foraging strategies of ruminant livestock on intensively managed grasslands: potential and constraints. Proceedings of the XVII International Grassland Congress New Zealand, p. 681-690.

Illius, A.W. and **I.J. Gordon.** 1990. Constraints on diet selection and foraging behaviour in mammalian herbivores. Pages 369-393 *in* R.N.Hughes, ed. Behavioural Mechanisms of Food Selection. NATO ASI Series Vol. G.20. Ecological Sciences, Springer-Verlag, Heidelberg, Berlin.

Laca, E.A., R.A. Distel, T.C. Griggs, G. Deo and **M.W. Demment.** 1993. Field test of optimal foraging with cattle: the marginal value theorem successfully predicts patch selection and utilisation. Proceedings of the XVII International Grassland Congress New Zealand, p. 709-710.

McRandal, D.M. and **P.B. McNulty.** 1980. Mechanical and physical properties of grass. Transactions of the ASAE **23**: 816-821.

de Vries, M.F. and **C. Daleboudt.** 1994. Foraging strategy of cattle in patchy grassland. Oecologia **100**: 98-106.

Stuth, J.W. 1991. Foraging behaviour. Pages 65-83 *in* R.K.Heitschmidt and J.W.Stuth, ed. Grazing Management. An Ecological Perspective.Tinker Press, Portland, Oregon.

Table 1
Experiment 1: Mean values of (a) grazing bites and (b) residence time for 9 treatment combinations
(means of 4 sequences * 3 sets per sequence)

Height(cm)	(a) Grazing bites			(b) Residence time (sec)		
	Bulk Density (mg DM/cm^3)			Bulk Density (mg DM/c^3)		
	1.33	1.51	1.67	1.33	1.51	1.67
19.6			53.5			55.3
16.4		45.5	46.7		42.8	43.1
13.3	31.3	30.8	32.0	27.1	25.7	27.5
10.3	4.2	4.8		3.2	3.7	
8.9	0.2			0.1		
	SEM ±1.63			SEM ± 1.56		

Table 2
Experiment 2: Mean values of (a) grazing bites and (b) residence time for 3 treatment combinations (means of 2 sequences * 6 sets per sequence)

Height(cm)	(a) Grazing bites			(b) Residence time (sec)		
	Patch Area		Patch Area			
	0.8m^2	0.4m^2	SEM	0.8m^2	0.4m^2	SEM
13.4	30.8	*	1.21	26.8	*	1.06
21.8	5.7	1.8	1.72	6.5	3.5	1.49