
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Does mowing before grazing increase dry matter intake and milk yield?

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Abstract

Mowing pasture before allocation of herbage to dairy cows is one management strategy suggested to improve feed quality, increase herbage dry matter (DM) intake and increase milk solids yield. To test these hypotheses, pasture at either a three or four week regrowth interval was offered to dairy cows 3 hours after pasture had been mown or as standing pasture. Forty-eight late lactation, Friesian x Jersey dairy cows were blocked into four groups and randomly allocated to each treatment. There was no effect of mowing or regrowth interval on botanical composition of the pasture on offer. Composition of herbage above 3.5 cm varied in DM content which was increased by mowing (13.2 versus 18.4% DM, P<0.05). For pastures with a three week regrowth interval, crude protein content was higher in the mown compared with standing herbage. At a similar herbage allocation, apparent DM intake was lower in mown (14.9 kg DM/cow/day) than in standing (15.5 kg DM/cow/day) treatments (P<0.05). This resulted in lower milk solids yield (P<0.05) in mown (1.24 MS/cow/day) compared with standing pasture (1.40 kg MS/cow/day). There was no apparent advantage in mowing ryegrass pastures in late lactation to improve herbage utilisation, DM intake or milk yield.

Keywords: pre-graze; *Lolium perenne*; grazing behaviour; tetraploid

Introduction

Successful pasture-based management systems require careful control of pasture quality, while ensuring maximum dry matter intake (DMI) for improved animal performance. To increase DMI, the allocation of herbage should be generous, as increasing DMI is associated with increasing herbage allocation which leads to higher weight gains and/or milk yield (Dalley et al. 1999; Engelbrecht et al. 2014). However, increasing the herbage allocation usually results in higher post-grazing residuals and reduced pasture utilisation (Mayne et al. 1987) as animals increase their diet selectivity. While there are short-term benefits in providing high herbage allocation, there are long-term trade-offs which are primarily a loss in quality due to build up of stem and dead material and a reduction in the amount of white clover content due to shading of stolons at the base of the sward (Hoogendoorn et al. 1988).

Depending on the type of farming system which is being operated there are a number of strategies used to deal with the disparity between feed quality and animal intake. In high-stocking-rate systems, pasture allocation is less than requirement, so supplementary feeds are used to meet requirements. In low-stocking-rate systems, mowing before or topping pastures after grazing has been used to reduce post-grazing residuals when animals are fed a high herbage allocation. However, in the small number of studies comparing the effect of consuming mown versus standing pasture in dairy production systems, the immediate response to mowing was consumption of lower quality pasture, reduced animal intake and lower milk yield (Kolver et al. 1999; Irvine et al. 2010). In those studies, however, pasture was mown 12-24 hours before allocation which may have contributed to reduced quality and in loss of dry matter (DM). The purpose of this study was to investigate the effect of mowing three hours before allocation on herbage quality, animal intake and milk yield in late summer and early autumn. To accentuate differences in pasture quality, two regrowth intervals were also tested to determine if interactions existed between mowing and changes in herbage quality during maturation.

Materials and methods

The study was carried out between 12 February and 29 March 2014 at the Lincoln University Research Dairy Farm, Canterbury (172.27°E; 43.38°S; 10 m above sea level) with the approval of the Animal Ethics Committee (AEC#555). The experimental design was a 2 x 2 factorial consisting of two pasture mowing treatments: pre-graze mowing versus the control standing, and two regrowth intervals: three weeks versus four weeks. A tetraploid perennial ryegrass (cv. Bealey) and white clover (cv. Kopu) pasture was established on a 9 hectare site including four spatially separated paddock blocks of 1.5 ha which were fenced using permanent fencing materials. The area was under pivot irrigation which was incorporated with the farm effluent system.

To test the longer-term effects of mowing, each paddock block was divided into four areas, based on anticipated herbage mass for three and four week regrowth intervals, using temporary polywire fencing. Between 12 and 18 February and between 6 and 10 March, the areas for the three week regrowth interval were either grazed or mown. Similarly between 23 and 28 February the areas for the four week regrowth interval were grazed or mown before offering to dairy cows. Urea (30 kg N/ha) was applied to four week regrowth areas on 3 March and to three week regrowth areas on 11 March. Mowing occurred between 1100 and 1200 hr using a mower (UFO, 2070W) attached to a tractor (John Deere, 6230) set to cut to a sward surface height of 3.5-4.0 cm.

The measurement period occurred between 20 and 29 March 2014 using 48 lactating, pregnant Friesian x Jersey dairy cows which were blocked according to milk yield (1.38 kg MS/cow/day) age (4.9 years), live weight (464 kg) and days in milk (212 DIM) and randomly assigned to four groups of 12 cows. Cows were adapted to their group and experimental conditions over three days on the first paddock block. Cows were milked daily at 0730 and 1530 h and were allocated a new 24 hour allocation of pasture following the afternoon milking. Cows had *ad libitum* access to fresh water from portable troughs. Allocation of pasture was 15 kg DM/cow/day above 3.5 cm post grazing residual (approximately 180 MJ of metabolisable energy (ME)/cow/day). The area to be allocated each day was determined on herbage mass by using an electronic rising plate meter (RPM, Jenquip) which measures compressed height. The manufacturers equation (compressed height 0.5 cm x 140 + 500) was used to estimate the herbage yield for daily allocation of all treatments. During the grazing experiment, the RPM was calibrated for each pasture treatment by determining the compressed height of 0.2 m^2 quadrat and measuring the dry weight of all herbage harvested to ground level within individual quadrats. Derived calibrations for standing (St) and mown (Mo) pasture at three week (3W) and four week (4W) regrowth intervals were:

4W St, kg DM/ha = 120.9 x $cm^{1.34}$ (R^2 = 0.93)
4W Mo kg DM/ha = 197.8 x $cm^{1.14}$ (R^2 = 0.79)
3W St kg DM/ha = 216.3 x $cm^{1.16}$ (R^2 = 0.82)
3W Mo kg DM/ha = 284.6 x $cm^{0.99}$ (R^2 = 0.88)

Apparent DMI was calculated using the following equation

$$DMI = \frac{(Pre-grazing\ mass\ -\ Post\text{-}grazing\ mass)x\ area\ (ha)}{No\ of\ cows}$$

where mass (kg DM/ha) was determined using calibration equations derived during the experiment.

Milk sampling took place in the morning and afternoon of 25, 27 and 29 March, 2014 when cows were shifted to a new paddock block. Whole milk was analysed for fat protein and lactose concentrations by near-infrared (Milkoscan™, Foss Electric, Denmark). Eating, ruminating and idling behaviour was observed every 5 mins for 24 hours for six cows in each treatment on the 24 and 27 March, 2014.

Botanical composition of herbage was determined for each paddock block during the measurement period (n=3) by cutting herbage samples to ground level before and after grazing. A subsample of approximately 50 g fresh weight was hand sorted into sown, weed and dead species, which were oven dried at 65°C for 48 h and dry weights recorded. For nutritive value, the long term effect of mowing in previous rotations were determined by daily sampling of herbage above ground level from standing herbage in all treatments at 1500 h. The immediate effects of treatments on nutritive value were determined daily by collecting samples above 3.5cm from mown (wilted) herbage and standing herbage at 1500 h. All herbage was freeze dried and ground through a 1 mm sieve. Organic matter (OM), crude protein (CP), soluble sugars and starch (SSS), neutral (NDF) and acid detergent fibre (ADF) and digestible organic matter in the dry matter (DOMD) were determined by near infrared spectroscopy (FOSS NIRSystems, Maryland USA).

Statistical analysis

Animal and herbage measurements were analysed using a randomised complete block design model. The three 1.5 ha paddocks were regarded as blocks as they were spatially and temporally separate. Regrowth interval and mowing treatment were fixed terms in the analysis of variance model. The ANOVA was carried out on 12 experimental units. Data from grazing behaviour used animals as a random term in the ANOVA model with regrowth interval, mowing treatment and their interaction as fixed terms in the model. Where treatments were significant ($P<0.05$), means were separated using Fishers Protected LSD test.

Results

There were no treatment effects on botanical composition on offer (above 3.5 cm). The pasture was dominated by perennial ryegrass (80 ± 2.5%), with a low proportion of white clover, weeds and dead material (5 ± 1.2% 4 ± 0.9% and 10 ± 2.7% respectively). Four week regrowth resulted in greater herbage mass, but mowing in the previous one or two rotations reduced herbage pre-grazing mass (Table 1). Post-grazing herbage mass and height were reduced by mowing. The effect of mowing on the nutritive value of the standing herbage is presented in Table 1. There was little effect of mowing in previous rotations on the chemical composition of herbage sampled to ground level. However the chemical composition of the herbage ingested was affected by treatment. Mowing pre-grazing, increased the DM% from 13% in standing herbage to 18% DM in mown herbage. An interaction between regrowth interval and mowing showed that CP content was greater for herbage at a three week compared with a four week regrowth interval and was not affected by mowing, but at four week regrowth interval mown pasture had a higher CP content compared with standing pasture (Table 1).

The derived calibrations from pasture cuts during the experiment were nonlinear, resulting in greater allocations than was targeted using the linear equation from the manufacturer (15 kg DM/cow/day above 3.5 cm). The herbage allocations above 3.5 cm, using the treatment calibrations, were: 16, 17, 15 and 18 kg DM/cow/day for 4W Mo, 4W St, 3W Mo and 3W St respectively. Apparent DMI was reduced by mowing and tended ($P<0.10$) to be greater for the three week than the four week regrowth (Table 2). Milk solids yield was lower in the four than the three week regrowth and lower on mown than the standing pasture (Table 2). There was an interaction between regrowth and mowing for milk fat percent which showed that at four week regrowth, milk fat was reduced by mowing and at three week regrowth milk fat was increased by mowing.

For cows on the three week regrowth treatment there was a tendency ($P<0.10$) to spend more time eating (70 minutes) standing pasture compared with mown pasture, while cows on the four week regrowth treatments spent the same amount of time eating whether the herbage was mown or not (Table 3). There was no significant effect of

Table 1 Effect of preparing pastures by mowing or grazing following a three week or four week regrowth interval on pasture mass, nutritive composition (% of dry matter (DM)) and digestibility of organic matter in dry matter (DOMD %) when comparing herbage sampled above ground level (standing pasture) or mown versus herbage sampled above 3.5 cm (ingested herbage).

	Three week		Four week			P value		
	Standing	Mowing	Standing	Mowing	SEM	Regrowth	Mow	M x R
Standing pasture above 0cm								
Pre-graze mass (kg DM/ha)	2128	1947	2834	2685	66.8	<0.001	0.05	0.81
Pre-graze compressed height (cm)	7.2	7.0	10.5	9.8	0.19	<0.001	0.08	0.18
Dry matter	15.0	15.2	15.4	15.1	0.4	0.74	0.93	0.53
Organic matter	90.0	89.5	89.6	89.5	0.5	0.70	0.60	0.70
Crude protein	19.4	18.1	17.5	18.0	0.62	0.21	0.55	0.22
Soluble sugars and starch	21.1	21.7	22.2	22.4	1.24	0.52	0.75	0.86
Acid detergent fibre	22.8	23.1	23.9	22.2	0.86	0.89	0.50	0.32
Neutral detergent fibre	40.1	40.8	41.5	37.4	2.73	0.74	0.58	0.46
DOMD	77.5	77.5	77.6	79.2	1.79	0.66	0.68	0.68
Ingested herbage above 3.5 cm								
Post-graze mass (kg DM/ha)	1096	988	1041	951	42.5	0.29	0.03	0.85
Post-graze compressed height (cm)	4.1	3.6	4.1	3.5	0.13	0.39	0.03	0.62
Dry matter	11.7	18.8	13.8	18.0	1.8	0.73	0.02	0.45
Organic matter	93.0[a]	90.2[b]	89.9[b]	89.8[b]	0.3	0.03	0.02	0.02
Crude protein	25.4[a]	24.3[ab]	19.9[c]	23.3[b]	0.5	0.005	0.13	0.03
Soluble sugars and starch	22.8	18.2	22.6	19.4	2.4	0.85	0.20	0.79
Acid detergent fibre	17.7	21.4	21.8	21.8	1.0	0.12	0.17	0.17
Neutral detergent fibre	32.6	38.9	37.6	39.3	2.4	0.35	0.20	0.41
DOMD	88.7	82.1	81.7	80.9	3.0	0.27	0.31	0.41

Means within rows with different superscripts are significantly different (P<0.05). SEM is the standard error of the mean for the interaction.

Table 2 Effect of preparing pastures by mowing or grazing following a three week or four week regrowth interval on dry matter (DM) intake, milk yield and composition of dairy cows.

	Three week		Four week			P value		
	Standing	Mowing	Standing	Mowing	SEM	Regrowth	Mow	R x M
Apparent DM intake (kg DM/cow/d)	15.3	14.5	15.7	15.2	0.24	0.07	0.05	0.55
Milk yield (L/cow/d)	14.6[a]	12.6[b]	13.1[b]	12.0[c]	0.16	<0.001	<0.002	0.03
Milk solids (kg/cow/d)	1.42	1.34	1.38	1.16	0.04	0.04	0.01	0.15
Milk fat (%)	5.54	6.14	6.15	5.72	0.21	0.66	0.69	0.05
Milk protein (%)	4.31	4.40	4.41	4.11	0.11	0.43	0.37	0.14
Milk lactose (%)	4.91	4.78	5.00	4.70	0.13	0.97	0.14	0.53
Milk fat (kg/cow/d)	0.793	0.778	0.799	0.676	0.03	0.1	0.03	0.07
Milk protein (kg/cow/d)	0.624	0.557	0.576	0.487	0.02	0.02	0.006	0.58
Milk lactose (kg/cow/d)	0.711	0.609	0.655	0.559	0.02	0.05	0.003	0.89

Means within rows with different superscripts are significantly different (P<0.05). SEM is the standard error of the mean for the interaction

Table 3 Effect of preparing pastures by mowing or grazing following a three week or four week regrowth interval on time (minutes/cow/day) spent eating, ruminating and idling by lactating dairy cows.

	Three week		Four week					
	Standing	Mown	Standing	Mown	SEM	Regrowth	Mow	R x M
Eating	624	555	589	591	12.0	0.95	0.07	0.06
Ruminating	293	321	327	342	12.4	0.11	0.18	0.62
Idle	321	366	319	307	12.7	0.10	0.28	0.11
Sitting	453	478	457	408	37.8	0.45	0.78	0.40

SEM is the standard error of the mean for the interaction regrowth or mowing treatment on time spent ruminating, idling or sitting down.

Discussion

This study was designed to test the effects of pre-graze mowing on nutritive value, DMI and milk solids yield of late-lactation dairy cows. It was hypothesised that mowing, leading up to and during the field study would result in improved nutritive value of herbage, enhanced apparent DMI, and greater milk solids yield, particularly in instances where long rotations and pastures of high biomass were being offered.

There were negligible effects of mowing on the chemical composition or digestibility of the herbage above ground level or grazing height (Table 1). The obvious change was a reduction in water content, reflecting wilting of the herbage. The low initial DM% is noteworthy as increased rumen water can negatively affect intake of high producing cows offered high feed allocation, particularly when fibre content is greater than 35% NDF (Dado & Allen 1995). However, the feeding level of animals in this experiment was only twice maintenance which is not regarded as high. Furthermore visual observations of grazing behaviour indicated that cows spent similar amounts of time grazing and ruminating on mown and standing pasture (Table 3).

The positive effect of offering shorter regrowth herbage on milk solids yield is consistent with earlier studies (Bryant et al. 2013; Holmes et al. 1992) which may reflect higher proportions of green leaf versus pseudostem in the short regrowth herbage. Perhaps if differences in quality were more pronounced, the benefits of mowing might be gained in subsequent grazing rotations. This was observed by Kolver et al. (1999) who showed the positive effects of mowing pre- or post-grazing to achieve lower post-grazing herbage mass, resulted in greater summer milk yield. Although extending the regrowth interval in the current study reduced milk solids, mowing was unable to correct this milk yield reduction. This is probably because grazing management in previous rotations achieved high pasture utilization minimising differences in residuals across treatments.

A feature of the current study was that apparent DMI was reduced by mowing resulting in lower milk yields for mown treatments. These findings are similar to those of previous studies (Irvine et al. 2010; Kolver et al. 1999). In those studies, which were carried out in spring, it was anticipated that during the plant reproductive phase, mowing would increase DMI. Instead the opposite effect was observed, with reduced DMI related to declining quality and palatability of mown pasture and a preference to graze standing pasture. In the current study, nutritive value was similar for the two treatment preparations, although the allocations were slightly lower for mown than standing pastures. Compressed height pre-grazing was similar for both treatments, but a single calibration equation did not pick up differences in pasture mass of previously mown compared with previously grazed pastures. A lower pasture mass from mowing may be due to lower defoliation height compared with grazing – this is reflected in the results (Table 1) - which lowered the regrowth rate. While numerically small, the resulting differences in allocation between mown and unmown treatments seems to be the most likely explanation for the difference in apparent DMI and milk solids yield. Based on pre and post graze mass, percentage utilisation of herbage was influenced by regrowth interval (49 versus 64% for three and four weeks respectively) rather than mowing (56 versus 57% utilisation for standing and mown respectively). However, if pasture mass tools are not separately calibrated, herbage utilisation for mowing (47%) appeared slightly higher than for grazing (43%). There is limited evidence to support the hypothesis that mowing herbage improves herbage utilisation, apparent DMI or milk production. However, when feed planning consideration should be given to the impact of frequent mowing on herbage yield and how it is measured, to avoid errors in allocation.

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