Change in herbage nutritive value of mown and standing pasture under rotational grazing

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Abstract

Varying the regrowth interval, pre-graze herbage mass and mowing pasture prior to grazing are strategies used to try to improve pasture quality and nutrient availability to grazing livestock. This study compared the nutritive value of pastures which had been mown before grazing, or grazed as standing pastures following a long (Long, 28 days) or moderate (Mod, 21 days) regrowth interval. Nutritive value and dry matter percent were determined at 0, 1, 2, 3, 4, 6, 12 and 24 hours in replicated paddocks during a 24-hour grazing period following allocation to dairy cows at 0700 h. Due to previous grazing management, which maintained a high proportion of leafy material in the grazed stratum, the nutritive value of the available herbage before grazing was similar for all treatments. Mowing before grazing resulted in a relatively constant nutrient supply over a 24 h grazing period; however, this did not alter cow performance (e.g., milksolids production or BCS) compared with grazing standing pasture. By contrast preferential selection of higher quality pasture by cows grazing standing pasture resulted in lower concentration of herbage crude protein ($P<0.05$) and greater concentration of fibre ($P<0.05$) at the end of the grazing period. When pastures were mown, herbage wilted, increasing DM from 17.5 to 39.4% DM within 24 hours ($P<0.05$). Despite large differences in pasture management, extending the regrowth interval and using repeated pre-graze mowing did little to alter herbage nutritive content.

Keywords: pre-graze mowing; cutting; *Lolium perenne*; rotational grazing

Introduction

Animal productivity in grazing systems is determined by the quality and quantity of the herbage offered, the potential production of the animal and the efficiency of utilization of nutrients in the herbage (Holmes 1989). The effect of defoliation frequency and intensity on growth (or quantity) of grass and clover pastures, and animal performance has been studied extensively, and collectively, these data indicate that longer regrowth intervals during spring increase pasture yield (Korte 1985, 1986; Parsons & Chapman 1989). However, longer regrowth intervals are also associated with reductions in feed quality and reduced utilization of available herbage (Michell & Fulkerson 1987). In an attempt to avoid negative carryover effects of poor pasture utilization, many farmers have adopted pre-graze mowing (PGM) which is the practice of mowing the pasture before allocation to stock (Boyce & Kerr 2013).

To address questions regarding the effect of pre graze mowing (PGM) on animal performance and herbage quality, a replicated-farm-systems experiment was carried out to determine the effect of PGM or grazing standing pastures after a long or moderate regrowth interval. The effect of PGM on animal performance has been reported, (Kay et al. 2018) which demonstrated, at the farm-system level, that mowing compromised pasture growth and there was no increase in cow dry matter intake (DMI), resulting in no net gain in milk production. In contrast, extending the regrowth interval by seven days (28 vs. 21 days), resulted in lower milk yield compared with moderate regrowth interval. Animal production is strongly influenced by both the quality and quantity of feed consumed. In order to explain the animal response to changes in pasture management the purpose of the present study was to quantify the impact of PGM and regrowth interval on herbage quality throughout a 24-hour grazing period.

Methodology

Experimental site and design

The experiment was carried out as part of a farm-systems experiment comparing the effects of regrowth and pre-graze mowing on pasture and cow performance (Kay et al. 2018). Eight ‘farmlets’ of 4.85 ha each and stocked at 3.3 cows/ha, were initiated on existing pastures at the Lincoln University Research Dairy Farm (Longitude 172°27′E; latitude 43°38′S; 10 m asl) between October 2016 and February 2017. The experimental area was irrigated, free draining Paparua sandy loam with Olsen P of 22 mg/L, pH of 6.1, sulphate S of 10.7 me/100 g and cation exchange capacity of 15 me/100g. Each duplicate farmlet represented one of four grazing management regimes to compare the effect of long (Long, 28 days) or moderate (Mod, 21 days) regrowth interval, which were grazed (Graze) or pre-graze mown (Mow) to control pasture mass under rotational grazing. The area consisted of pastures of either late flowering diploid of cv Arrow AR1 or Trojan NEA2 perennial ryegrass and white clover (70% of the area), or late-flowering tetraploid cultivars cv Bealey AR1 also sown with white clover (30% of the area).

Pastures and management

To test the effects of grazing management on nutritive value during a grazing period, sampling occurred in January and February, when all farmlets had been exposed to their management regime (grazing versus mowing at long or moderate regrowth intervals) on at least three previous rotations. Grazing plans were established for each farmlet at the commencement of the week of the 9th of January and the 13th of February 2017 (respectively weeks 12 and 17 of the larger systems experiment). Paddocks for each farmlet were selected for sampling to ensure pastures were representative of each treatment. For example, paddocks were balanced for ploidy, previous grazing date, pre-graze pasture mass, and soil type. Each day (Tuesday, Wednesday, Thursday) only two or three farmlets were sampled to avoid any delays between removal of sample in the paddock and processing in the laboratory. Approximately 300 g fresh wet of available herbage (4 cm above ground level) was sampled into snap-lock bags at 0, 1, 2, 3, 4, 6, 8, 12 and 24 h after allocation by plucking (mown) from the centre of the swath, or clipping (standing) pasture at 10 locations in each paddock across a diagonal transect. Herbage was immediately placed on ice packs in an insulated container and processed in a nearby laboratory within 30 minutes. Hour 0 occurred at approximately 0700 h, when mowing commenced. Cows entered their respective paddocks between 0730 and 0830 h and apart from removal for afternoon milking for 60-90 minutes at 1500 h, they remained in their paddock until 0600 h the following day. Compressed height of pasture was measured using a rising-plate meter prior to mowing and after the cows had finished grazing. Calibration equations for each treatment were derived for the farmlets every month, to estimate pasture mass based on quadrat cuts collected during the experimental period.

Herbage samples were mixed and a subsample of approximately 50 g fresh weight. Fresh weight was recorded and the sample was oven dried at 60°C to a constant weight and dry weight recorded to determine dry matter percent. The oven-dried herbage was then ground to pass through a 1-mm sieve and analysed for crude protein (CP), crude fibre (NDF), soluble sugars and starch (SSS) and digestible organic matter in the dry matter (DOMD) using near-infrared spectrophotometer (NIRS; Model: FOSS NIRSystems 5000, Maryland, USA). Calibration coefficients were derived from perennial ryegrass samples and R-squares for all parameters exceeded 0.97.

Separate herbage samples (herbage above 4 cm) were collected from a cross section of paddocks from each farmlet during January (week 12) and February (week 17). Bulk samples were mixed, sub sampled and hand sorted into sown, dead and weed species for botanical assessment. Twenty ryegrass tillers were extracted from the above sample and the number of leaves per tiller were counted for leaf stage determination.

Animal measurements

The impact of any differences in nutritive value (NV) on the time spent grazing or ruminating was determined from four cows per farmlet using eartags containing motion sensors (SensOor, CowManager Netherlands, for technical details see Bikker et al. 2014).

Statistical analysis

Botanical parameters were averaged for each farmlet and mean total grazing and ruminating times (minutes/day) per farmlet replicate were compared using GLM procedure of Genstat (V. 16.1 VSN International Ltd) where pasture regrowth and mowing and their interaction were used as fixed terms, month as a blocking term and replicate as a random term. Change in nutritive variables over time were analysed using a mixed models approach to repeated measures analysis of variance (Proc Mixed, SAS/STAT 14.3). Pasture regrowth, mowing, elapsed time since allocation (hour), and their interactions were included as fixed effects and paddock as random effect. Analysis of variance was followed by pairwise comparisons using Tukey adjustment. Results are presented as least-squares means and standard error of the difference. Significance was declared if $P \leq 0.05$.

Results

There was no effect of treatments on ryegrass (72%), weed (7%) or clover (11%) content, but in January (week 12) there was more dead material in Long Graze (11%) than Long Mow (3%) and similar dead material in Mod Graze or Mow (6%). By February (week 17) there was 10% dead material across all farmlets. There were no treatment effects on leaf number which were 2.7±0.33 and 2.2±0.28 leaves/tiller in week 12 and 17 respectively. Pre-graze pasture height and estimated herbage mass were greater for the Long compared with the Mod treatment (Table 1). An interaction for NDF between regrowth interval and harvesting method ($P = 0.03$, Table 1) showed that fibre content was greater in the Long-Mow compared with the Long-Graze treatment at time 0 ($P<0.05$), but did not differ among the other treatments. There were no main effects of harvesting method on other nutritive components in offered herbage. There was a main effect of regrowth interval for CP showing that a longer regrowth interval (to achieve high mass) resulted in pastures with lower CP content ($P<0.05$). At hour 0, the mean dry matter content of pastures was similar for all treatments ($P=0.87$).

There were no interactions between regrowth interval and time for any of the nutritive variables during the grazing period, nor were there interactions between harvesting method and time for SSS and DOMD. However, there were interactions between harvesting method and time for CP, NDF and DM% ($P<0.001$, Figure 1). Throughout the grazing period, the NDF content of residual herbage in Mow did not alter, yet in Graze, the NDF content of residual herbage increased rapidly between 8 and 24 hours after allocation. In contrast, CP in the residual herbage remained constant in Mow treatments but declined rapidly between 0 and 12 hours for Graze treatments. An interaction ($P<0.001$) between harvesting method and time for DM% of residual herbage showed that, when grazed, the DM% was similar at the start and end of the grazing period, whereas residual mown herbage increased in DM from 17.5 to 39.4% (Figure 1).

There were no interactions between harvesting method and regrowth interval for grazing behaviour variables during the sampling period. There was no effect of regrowth interval on total grazing time (GT, 618±10.8 minutes/d) or ruminating time (498±10.4 mins/d). However, cows in the Mow treatment grazed for 42 mins less (639 versus 597 minutes per day; $P<0.05$) and had

Figure 1 Effect of grazing (closed symbol) or mowing (open symbol) on change in residual herbage content of soluble sugars and starch, crude protein, neutral detergent fibre and digestible organic matter in the dry matter during the course of a 24 hour grazing period with dairy cows where Hour 0 is 0700 h. Error bars represent the standard error of the difference.

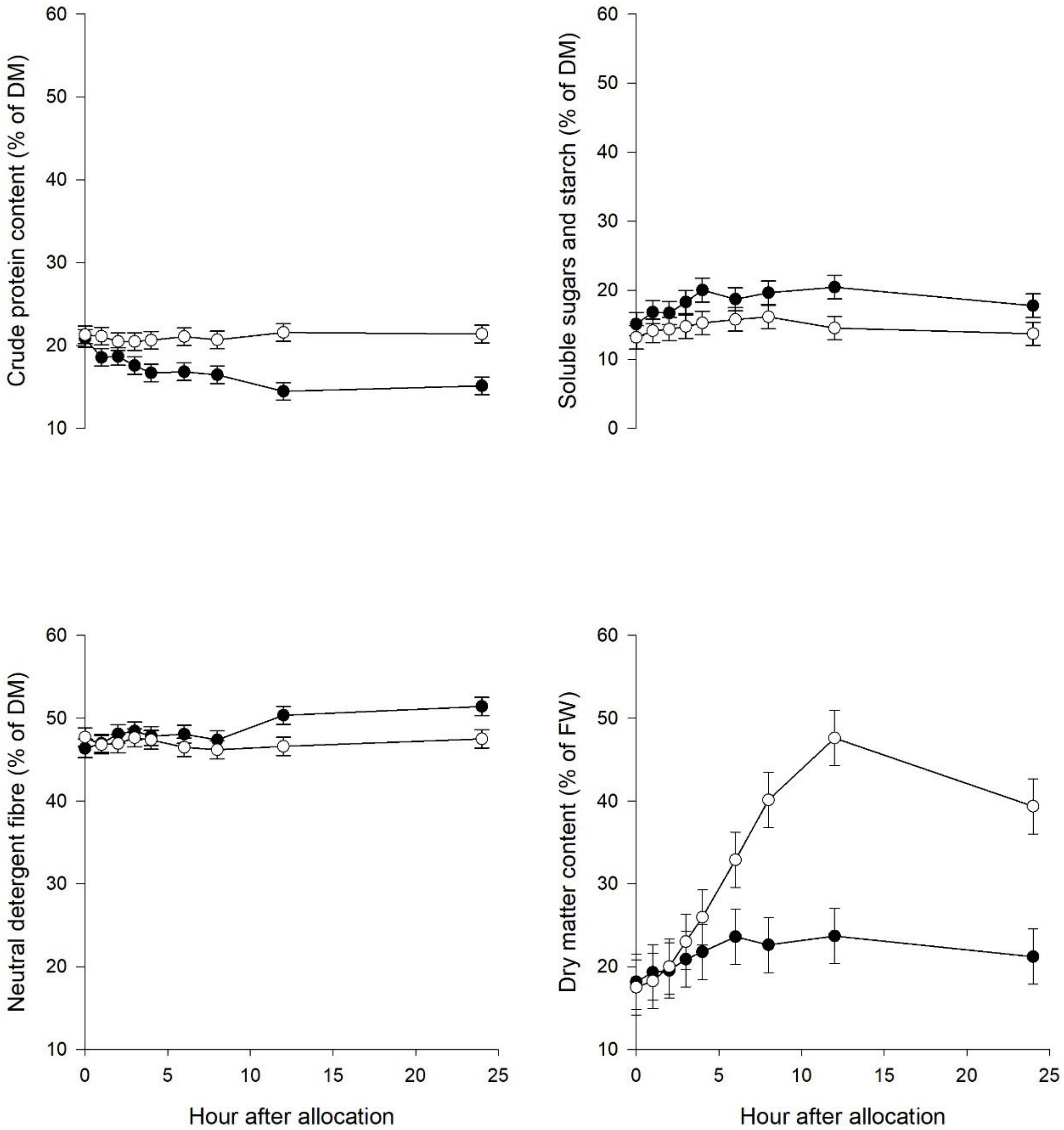


Table 1 Effect of grazing (Graze) or mowing (Mow) pastures grown after a long (Long) or moderate (Mod) regrowth interval on physical and chemical characteristics prior to the start of a grazing period (time 0 h)

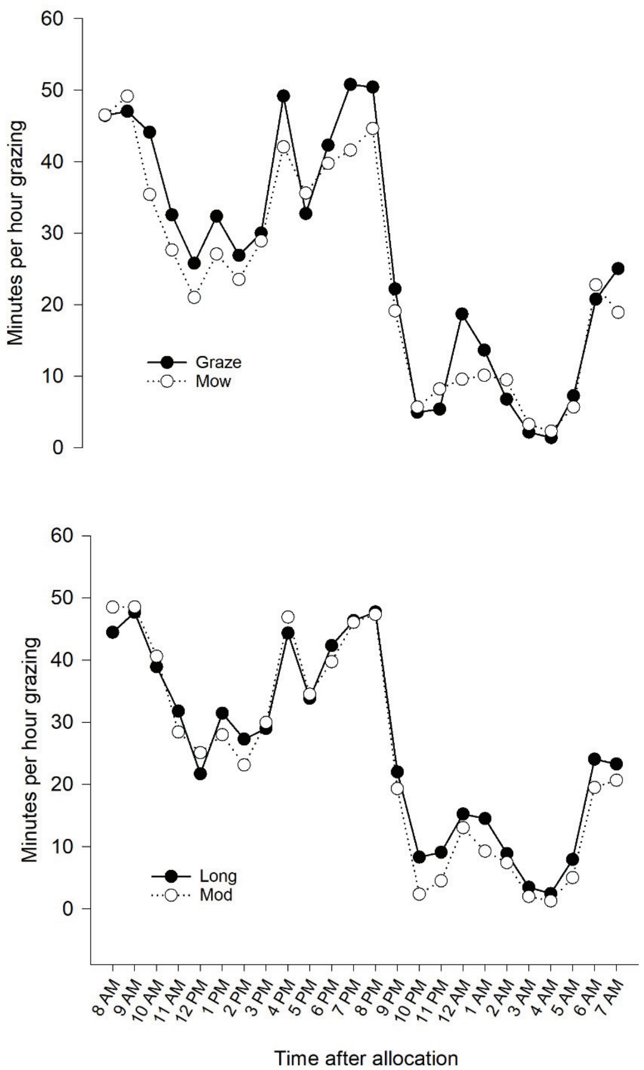
	Graze		Mow			P value		
	Long	Mod	Long	Mod	SED	Regrowth	Mow	R x M
Pre mass (kg DM/ha)	4123	2865	4505	3230	347	<.001	0.15	0.98
Pre height (compressed cm)	10.0	8.7	21.5	10.8	0.56	<.001	0.56	0.07
Dry matter (% FW)	18.2	19.4	18.1	15.6	4.7	0.56	0.85	0.87
Neutral detergent fibre (% DM)	45.0[b]	47.7[ab]	49.5[a]	46.0[ab]	1.56	0.71	0.22	0.03
Soluble sugars and starch (% DM)	17.2	13.0	14.0	12.4	2.44	0.08	0.26	0.18
Crude protein (% DM)	19.8	21.9	19.6	23.0	1.50	0.01	0.67	0.07
Digestibility of organic matter in the DM (%)	76.4	73.8	72.9	74.2	1.70	0.58	0.20	0.22
Post mass (kg DM/ha)	2228	1610	2177	1893	232	0.08	0.63	0.49
Post height (compressed cm)	5.0	4.6	4.5	4.1	0.22	0.02	0.01	0.66

greater ruminating time (479 to 518 minutes per day; P<0.05) than did Graze treatments. The variation between mowing and grazing for GT can be seen in Figure 2 which shows cows grazing standing pastures had more intensive (more minutes per hour grazing) grazing bouts compared with cows grazing mown pastures. Compared with Mod or Mow, cows in Long and Graze treatments had greater post-grazing heights, though variation in bulk density of the herbage resulted in similar estimates of post-graze mass (Table 1).

Discussion

In spite of differences in the pasture management decision rules prior to this study (mowing vs grazing standing pastures and long vs moderate regrowth interval), the quality of the pasture on offer was similar. This is consistent with previous studies (Bryant et al. 2016; Cun

Figure 2 Effect of grazing versus mowing (top) and long versus moderate (Mod) regrowth intervals (bottom) on grazing duration per hour of lactating dairy cows throughout a 24 hour allocation. Effect of grazing versus mowing (top) and long versus moderate (Mod) regrowth intervals (bottom) on grazing duration per hour of lactating dairy cows throughout a 24 hour allocation.



et al. 2017) and is likely the result of both good pasture management and sampling method of collecting herbage within the grazing stratum. Although advancing maturity in pastures is associated with a decline in pasture quality (Chaves et al. 2006), in this study, temperature, irrigation, N fertilisation and consistent management to ensure growing conditions were not limiting and target residuals were met. This likely ensured continual regrowth of new leaf and maintained quality. The regrowth interval of Long and Mod were 28 and 21 days respectively, during which period leaf appearance had not reached the maximum three live leaves per tiller, so senescence was relatively low in both treatments. The sampling procedure also aimed to capture what was available to cows above 4cm and close monitoring and achievement of target post-graze pasture mass throughout the farmlet study made it easy to identify the grazing stratum, which was predominantly leafy.

Studies of grazing behaviour show clearly that herbivores sequentially graze leaf, stem and dead material in order of preference and availability in the vertical profile of the sward (Cullen et al. 2017). This sequential preference will likely result in deterioration in quality or residual herbage during grazing due to the composition of less preferred plant tissues. However, there is little documented data informing the rate of deterioration or what impact that this has on animal performance. The current work demonstrates that sequential grazing of standing pastures lead to immediate rapid reduction in protein content and delayed increase in fibre content of residual herbage. By contrast, with the exception of dry matter, which increased largely as a result of water evaporation, there was no evidence of diet selection by cows grazing mown pastures. Given that harvesting method did not affect the nutrient content of the herbage on offer, the lack of animal response to harvesting method reported by Kay et al. (2018) for the farm systems study suggest that the sequence of supply of nutrients during a 24 hour grazing period is not an important determinant of productivity either.

At the outset of the larger farm systems study we hypothesised that mowing pastures at Long regrowth could improve animal production by improving pasture quality. In the present study, herbage quality was not affected by previous mowing, and the availability of green leaf material above grazing height was similar for mowing and grazing treatments as indicated by similar leaf number per tiller. In addition, the lack of selection from cows grazing mown material, and the substantial amount of mown material that was not eaten (~ 2 kg DM/cow/grazing period; Kay et al 2018) likely explains the lack of difference in performance between cows grazing mown and standing pastures. Previous research has shown that DM intake is positively correlated with DM content of pasture (John and Ulyatt 1987; Estrada et al. 2004). In the present study, mowing pastures increased DM content without compromising quality of herbage during a 24-hour grazing period. However, mowing reduced grazing time by 42 minutes and increased ruminating time by 39 minutes, which is likely to be the result of increased particle size of mown compared to grazed herbage and the need for greater rumination to reduce bulk density (Yansari et al. 2004; Esmaeili et al. 2016).

These results demonstrate that there was no difference in the nutritive value of long or moderate regrowth pastures following several rotations of mowing or grazing during spring/summer using irrigated pastures. These data indicate that cows grazing standing pastures consume protein rapidly and fibre more slowly, in comparison with mown pastures, where cows eat a consistent nutritive value composition throughout the day.

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