Immediate and Carryover Effects of Post-Grazing Sward Height Imposed in Early Spring on Sward and Milk Production

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Abstract. A grazing experiment was undertaken to investigate the immediate and carryover effect of post-grazing sward height (PGH) in early spring on sward and dairy cow production. Ninety Holstein-Friesian spring calving dairy cows were randomly assigned across 3 PGH treatments: 2.7, 3.5 and 4.2 cm from February 14 to April 24, 2011. Following the experimental period animals were managed similarly until the end of the lactation. Grazing to 2.7 cm during the experimental period reduced milk (-159 kg/cow; $P<0.01$) and milk solids (-16 kg/cow; P<0.01) yields and increased BW loss (+13 kg loss; $P<0.05$) when compared to the 3.5 and 4.2 cm treatments which performed similarly. Grass utilisation (>2.7 cm) increased ($P<0.001$) by decreasing PGH from 4.2 cm (0.74) to 3.5 cm (0.82) and further to 2.7 cm (0.94). During the carryover period (April 24 to November 13), cumulative milk (3542 kg/cow) and milk solids (281 kg/cow) yields did not differ between the experimental treatments. End BW was similar across treatments (503 kg). Total lactation performance of cows grazing to 2.7 cm in spring was -24 kg milk solids ($P<0.05$) than the total lactation production of the 3.5 and 4.2 cm treatments (405 kg milk solids) indicating that cows offered a restricted pasture allowance in early lactation do not recover lost production. This study recommends a PGH of 3.5 cm in the first 2 grazing rotations to achieve a compromise between sward utilisation and animal performance in early spring while also ensuring high subsequent lactation milk production.

Keywords: Post-grazing residuals, dairy cow, lactation, pasture utilisation.

Introduction

The ability to grow a large quantity of grass, the cheapest feed available, is a unique advantage conferred on dairy farmers from temperate regions of the world. Ireland is one of these regions; therefore the Irish dairy industry must seize the opportunity to expand its grass-based production system in order to secure its competitive position on the international market. The Irish Government has targeted a 50% increase in milk production by 2020 (DAFF 2010). To achieve this target pasture management and utilisation must be improved. This can be achieved through early spring turnout of the post-parturient cow which will maximise the use of grazed grass in the dairy cow's diet. Herbage availability however, is limited in early spring. Grazing pastures to lower post-grazing sward heights (PGH) than that currently recommended (4.0 cm; McEvoy *et al*. 2008) during the first 2 grazing rotations would ensure greater herbage availability during this period. Previous studies reported a reduction in milk yield (MY) with decreasing PGH due to a lower grass allowance per cow (Kennedy *et al*. 2007; McEvoy *et al*. 2008). Conversely, grazing swards to low PGH in spring were found to increase herbage quality for the following grazing rotations and support greater subsequent milk production (Kennedy *et al*. 2006). Carryover effects of early lactation nutrition on dairy cow lactation performance are unclear. The variations in diet (Friggens *et al*. 1998), timing of restriction and the duration and amplitude of restriction (Grainger and Wilhelms 1979; Delaby *et al*. 2009) between experiments may explain the inconsistency in the findings. Grass utilisation classically increases with decreasing PGH but there is limited information regarding the effect of a constant PGH imposed in the spring on annual DM production. The objectives of this experiment were to investigate the effect of early lactation PGH on: (1) immediate, carryover and lactation milk production performance; and (2) on annual grass DM production.

Materials and methods

The experiment was undertaken at the Animal & Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland. The experiment was conducted as a randomised block. Ninety (27 primiparous and 63 multiparous) spring calving Holstein Friesian dairy cows were balanced on the basis of calving date (February 13; s.d. 17.7 days), lactation number (2.1; s.d. 1.04), previous lactation MY for the multiparous cows (4588; s.d. 670.8 kg/cow) and dam's first lactation MY for the primiparous cows, milk fat (42.0; s.d. 4.08 g/kg), protein (33.8; s.d. 1.81 g/kg) and lactose (46.3; s.d. 1.15 g/kg) concentrations, bodyweight (BW; 482; s.d. 56.6 kg) and body condition score (BCS; 2.92, s.d. 0.139). Animals were randomly assigned directly post-calving to one of three PGH treatments (n=30): 2.7 cm (severe – S), 3.5 cm (low – L) or 4.2 cm (moderate – M). Treatments were imposed for 10 weeks, from February 14 to April 24 2011.

Following the experimental period, animals were managed similarly to monitor carryover effects, until 13 November. An equal grazing area was assigned to each treatment and treatment herds were managed independently. During the experiment, animals were offered fresh grass following each a.m. and p.m. milking and on a 24-h basis during the carryover period due to drier ground conditions. Post-grazing sward heights were measured before cows returned to the paddock following a.m. milking. If the target PGH was not achieved animals remained in their previous day's grazing area until they grazed to their target PGH. Consequently daily herbage allowance and area grazed per cow/day fluctuated throughout the experiment due to differences in pre-grazing herbage mass and the requirement to keep PGH constant. The amount of concentrate offered to animals was the same across treatments during the experimental period (3.3 kg DM/cow per day, on average). Herbage mass (HM) above 2.7 cm was estimated by harvesting two strips per grazing treatment twice weekly, using a motor Agria (Etesia UK Ltd, Warwick, UK). If the height following harvest was different from 2.7 cm, HM was corrected to 2.7 cm. Pre- and post-grazing sward heights were measured daily with a pasture plate meter (diameter 355 mm and 3.2 kg/m²; Jenquip, Fielding, New Zealand). Grass utilisation (>2.7 cm) was calculated using the pre-grazing HM relative to the post-grazing HM. Once a week, herbage was defoliated to the respective PGH of each treatment and frozen at -20ºC following collection. Herbage samples were bowl-chopped, freeze-dried, and milled before chemical analysis (DM%, ash, ADF, NDF, CP and OMD). Milk yield was recorded daily; milk composition, BW and BCS were measured weekly. Grass dry matter intake (GDMI) was measured using the n-alkane technique (Dillon and Stakelum, 1989) during weeks 5 (March 12-18) and 9 (April 11-16) of the experiment.

Animal variables were averaged per cow and period (experimental, carryover and total lactation periods) and analysed using covariate analysis in SAS (PROC MIXED) with terms for parity, treatment, and the interaction of treatment and parity. The covariates included days in milk and; i) the pre-experimental production values for the analysis of the experimental and lactation periods data; ii) the experimental production values for the analysis of the carryover period data. Herbage data were analysed by ANOVA using the terms for treatment and rotation.

Results

Pasture characteristics

Target PGH was achieved for each of the S (2.7 cm), L (3.5 cm) and M (4.2 cm) treatments. The M treatment had higher pre-grazing HM (+120 kg DM/ha; *P*<0.01) and pre-grazing height (+0.6 cm; *P*<0.001) when compared to S and L which recorded similar values (956 kg DM/ha and 6.4 cm, respectively). Decreasing PGH from M to L and further to S resulted in lower (*P*<0.001) daily herbage allowance per cow from 12.1 to 10.0 and to 7.7 kg DM/cow (s.e.d. 0.31), respectively, whereas grass utilisation decreased from 0.94 to 0.82 to 0.74 (s.e.d. 0.041; *P*<0.001) from S to L to M. The S animals required less area per day over the entire 10-week experimental period (-37 m^2/cow per day; *P*<0.001) than the L and M animals (129 m^2/cow per day, on average; s.e.d. 18.0). At the end of the first grazing rotation (March 31), the actual area grazed increased from 14.9 ha (S) to 16.1 ha (L) to 19.0 ha (M). Treatment had no effect on herbage DM%, ash, ADF, NDF, CP, and OMD during either the experimental or carryover period. Cumulative grass DM production at the end of the experiment was not significantly different between treatments but increased numerically with increasing PGH from 2.7 to 3.5 to 4.2 cm (1.69, 1.91 and 2.36 ton DM/ha, respectively; s.e.d. 0.255). There was no carryover effect of spring PGH on subsequent grass DM production (14.6 ton DM/ha, on average).

Animal production

Imposing a PGH of 2.7 cm during the experiment significantly decreased dairy cow MY (-2.1 kg/cow per day; *P*<0.001) and milk fat concentration (-2.2 g/kg; *P*<0.05) when compared to the average of the L and M treatments (Table 1). The S animals also produced lower (*P*<0.001) yields of milk fat (-127 g/day, s.e.d. 30.6), protein (-90 g/day, s.e.d. 18.8) and milk solids (-214 g/day; Table 1.) than the average of the L and M treatments (1116, 825, and 1940 g/day, respectively). Grazing to 2.7 cm during the experiment reduced 10-week cumulative MY (-159 kg/cow; *P*<0.01) and 10-week cumulative milk solids yield (-16 kg milk/cow; *P*<0.001), when compared to the L and M treatments which had similar 10-week cumulative milk (1513 kg/cow) and milk solids production (120 kg/cow). Over the experiment, the BW and BCS losses of the S cows (-18 kg and -0.29) were greater than that lost by the L and M cows which performed similarly (Table 1). Results from the first GDMI measurement period show no significant difference between treatments (10.3 kg DM/cow per day); all animals were offered 4.0 kg DM of concentrate/cow per day. During the second measurement of GDMI, the S animals ate 1.1 kg DM less (*P*=0.001) than the L and M animals which recorded similar GDMI values (12.8 kg DM/cow per day) and with no concentrate supplementation.

During the carryover period, the L cows had lower milk fat (-0.9 g/kg) and protein concentrations (-0.4 g/kg) than the S and M cows which did not differ significantly (Table 1).There was no carryover effect of early lactation PGH on subsequent MY, yields of milk fat (740 g/cow, s.e.d. 15.6), protein (617 g/cow, s.e.d. 12.4) and milk solids yield (1357 g/day). Throughout the carryover period, there was no significant difference between the S, L and M treatments in cumulative MY (3542 kg/cow) or milk solids yield (281 kg/cow). The S animals lost less BCS throughout the carryover period when compared to the L and M animals (Table 1). There was no carryover effect of early lactation PGH on subsequent animals GDMI (16.1 kg DM/cow per day; s.e.d. 0.34).

Total lactation milk protein yield was significantly reduced (*P*<0.05) on the S treatments when compared to M and L (Table 2). Also, the S cows recorded lower (*P*<0.05) total lactation MY (-284 kg/cow) and milk solids yield (-24 kg/cow) than the L and M cows (Table 2). BW (503 kg)

Table 1. Effect and carryover effect of post-grazing sward height (PGH) on dairy cow performance

PGH treatment[1]	S	L	M	s.e.d.	*P*-value
Experimental period (February 14 to April 24)					
Milk yield (kg/day)	22.0 a	23.6 b	24.6 b	0.51	<0.001
Milk fat concentration (g/kg)	44.8 a	47.1 b	46.7 b	0.91	0.027
Milk protein concentration (g/kg)	33.3	34.2	34.2	0.35	0.091
Milk solids yield (g/day)	1730 a	1914 b	1974 b	0.046	<0.001
Bodyweight change over period (kg)	-18 a	-4 b	-6 b	3.2	0.025
Body condition score change over period	-0.29 a	-0.21 ab	-0.15 b	0.040	0.010
Carryover period (April 25 to November 13)					
Milk yield (kg/day)	17.1	17.8	17.5	0.37	0.085
Milk fat concentration (g/kg)	43.8 b	42.9 a	43.8 b	0.65	0.036
Milk protein concentration (g/kg)	36.0 b	35.7 a	36.2 b	0.28	0.023
Milk solids yield (g/day)	1332	1366	1373	27	0.161
Bodyweight change over period (kg)	+43	+33	+45	5.6	0.061
Body condition score change over period	-0.02 a	-0.12 b	-0.11 b	0.042	0.053

[1]Post-grazing height: S, 2.7 cm; L, 3.5 cm; M, 4.2 cm; s.e.d = SE of the difference; Means within a row with different letter differ (*P*<0.05).

Table 2. Effect of post-grazing sward height (PGH) on dairy cow total lactation performance (February 14 to November 13)

PGH treatment[1]	S	L	M	s.e.d.	*P*-value
Cumulative milk yield (kg/cow)	4830 a	5130 b	5099 b	124.8	0.031
Milk fat yield (g/kg)	857	899	896	18.2	0.090
Milk protein yield (g/kg)	639 a	676 b	679 b	14.6	0.029
Cumulative milk solids yield (kg/cow)	381 a	404 b	406 b	10.2	0.020

[1]PGH: S = 2.7 cm; L = 3.5 cm; M = 4.2 cm; s.e.d. = SE of the difference; Means within a row with different letter differ (*P*<0.05).

and BCS (2.68) did not differ significantly between treatments at the conclusion of the study.

Discussion

This experiment aimed to determine the effect of early lactation PGH on: (1) immediate and total lactation milk production performance; and (2) on annual grass DM production and utilisation. The results from the current study emphasise the large reductions in GDMI and milk production performance of early lactation dairy cows that occur when a very low PGH (*e.g.* < 3.0 cm) is imposed. Imposing a PGH of 2.7 cm resulted in low herbage availability per cow per day, which explains the limited intake of the S animals. Cows were unable to increase GDMI as they were physically restricted to graze further into the sward horizon which was predominantly comprised of stem and dead material below 2.7 cm. The reduction in GDMI consequently resulted in lower MY and increased BW and BCS losses. In contrast, the L and M cows were less restricted by the PGH imposed and were offered a greater grazing area per cow per day, thus were able to increase GDMI.

The greater nutrient availability on those treatments resulted in increased milk synthesis and avoidance of excessive BW loss during early lactation. The similarities in mean GDMI between the L and M herds support the similar cumulative production performance at the end of the 10-week experimental period. There was no carryover effect of early lactation PGH on milk and milk solids production during the remainder of the lactation (April to November). This emphasises that dairy cows previously restricted are able to increase milk production when the availability of nutrients from pasture is no longer limited (Friggens *et al*. 1998). Indeed, animals were able to adjust their GDMI in accordance with the quantity of herbage available. The large milk solids yield loss (16 kg) on the S treatment during the experiment accounted for most of the total lactation losses (24 kg) when compared to the L and M cows which performed similarly.

As expected, grass utilisation increased with decreasing PGH in this experiment. Decreasing PGH from 4.2 cm to 3.5 cm resulted in a greater requirement for grazing area at the end of the first grazing rotation. This is an important result given the low grass growth rates and low grass availability in early spring. Following the first 2 grazing rotations, the greater DM production on the M treatment seems to be the consequence of more lenient grazing during this period, when compared to the 2.7 cm and 3.5 cm PGH. A more lenient grazing (M swards) during the experiment did not reduce herbage quality when compared to the L and S treatments. This is likely to be due to the timing of the experiment, in early spring, when perennial ryegrass is in a vegetative stage before the initiation of reproductive stage and stem elongation. This resulted in short sheath height across the 3 swards, hence the similar herbage quality between treatments.

Conclusions

The present experiment demonstrated that imposing a very low PGH such as 2.7 cm at the beginning of lactation maximises grass utilisation but significantly reduces cow production and increases BW and BCS losses. In comparison to a 3.5 cm PGH, grazing to 4.2 cm reduced grass utilisation and did not lead to any additional benefits in terms of cumulative milk production at the end of experiment, thereby compromising the profitability of this system. Carryover milk and milk solids production were not affected by spring PGH, however total lactation milk and milk solids production were reduced when spring PGH was <3 cm. This result is critical given that the majority of Irish milk producers are paid on the quantity of milk solids produced. Consequently, Irish dairy farmers are recommended to graze pastures to a PGH of 3.5 cm during the first 2 grazing rotations to achieve high milk output from pasture and high grass utilisation.

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