Short Communication: Effect of Postgrazing Residual Pasture Height on Milk Production

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ABSTRACT

In grazing systems, dry matter intake (DMI) and milk production have been reported to increase with increasing pasture allowance (PA). This has often led to greater postgrazing residual heights being associated with a well-fed cow. However, in previous studies pastures were often managed to be homogeneous pretreatment, confounding the effect of postgrazing height and PA because high PA led to high postgrazing height. The objective of this study was to determine whether postgrazing height affects milk production if cows are offered the same PA. Before the study, perennial ryegrass (*Lolium perenne* L.) dominant pastures were randomly allocated to 1 of 3 grazing treatments and defoliated to 4.1 ± 0.3 (low), 5.1 ± 0.3 (medium), or 5.9 ± 0.3 (high) cm compressed postgrazing residual pasture height. When a minimum of 2 new leaves had emerged on the majority of ryegrass tillers, 30 multiparous dairy cows were randomly assigned to 1 of the 3 treatments and grazed their respective pastures over a 10-d period. Cows were offered a similar PA above the preexperimental postgrazing residual (17.1 ± 2.9 kg of dry matter/cow per d). Pasture disappearance per daily grazing area (estimated DMI) was similar across treatments (14.8 kg of dry matter/cow per d). Milk yield was negatively correlated with postgrazing height, but postgrazing height had no effect on milk component yield. Although the reason for this reduction in milk yield remains unclear, data indicate that low postgrazing heights do not adversely affect milk production.

Key words: milk production, pasture postgrazing residual, grazing

In grazing systems, DMI, the main determinant of milk production (Holmes et al., 2002), is primarily controlled by pasture allowance (PA; Nicol and Nicoll, 1987). It has been reported that large amounts of pasture must be offered to achieve high DMI and milk

production (Stakelum, 1986; Stockdale, 2000). Pasture allowance is affected by both the pregrazing mass of the pasture and the area allocated to the cows for grazing. In previous studies, when pretreatment pastures were homogeneous (Le Du et al., 1979; Wales et al., 1998), decreasing PA (i.e., providing smaller grazing areas) lowered milk production. It also reduced the postgrazing residual or height. This has contributed to the belief that low postgrazing heights (more intensive grazing) reduce milk production (Mayne et al., 1987), when in fact the effect of grazing intensity cannot be separated from the confounding effect of PA in those studies.

One of the consequences of increasing PA to raise milk production is a corresponding rise in the postgrazing pasture residual. This is likely to decrease the quality of the pasture in subsequent rotations because of increased stem production and accumulation of dead material (Michell and Fulkerson, 1987; Stakelum and Dillon, 1990; Lee et al., 2007) and may reduce pasture production/ha (Lee et al., 2008; Macdonald et al., 2008) and pasture consumed/ha (Dalley et al., 1999; Wales et al., 1999; Macdonald et al., 2008), which are both important determinants in the profitability of grazing farms (Dillon et al., 2005). To determine the real effect of grazing intensity on milk production, it must be separated from the confounding effect of PA.

The objective of this study was to determine whether previous postgrazing height affects milk production if cows are offered the same PA.

The experiment was conducted at Elliott Research Station, Burnie, Tasmania, Australia (41.1°S 145.8°E; elevation 130 m) over a 10-d period in October 2006. The animal ethics committees of the Tasmanian Department of Primary Industries and Water and the University of Tasmania approved all procedures.

Before the experimental period, 12 grazing areas were randomly allocated to 1 of 3 grazing treatments (low, medium, or high postgrazing residual height), ensuring treatment areas were balanced for botanical composition and walking distance to the milking parlor. Over a period of 13 d during early spring (preexperimental period), pastures were grazed to 4.1 ± 0.3 (low),

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5.1 ± 0.3 (medium), and 5.9 ± 0.3 (high) cm compressed postgrazing height [readings from a rising platometer (RPM); Farmworks, Palmerston North, New Zealand] to generate the experimental comparison. Once a minimum of 2 leaves had appeared on the majority (>66%) of perennial ryegrass tillers (25 to 28 d), pastures were deemed ready to be grazed (Fulkerson and Donaghy, 2001).

Thirty multiparous Holstein-Friesian × Jersey cross-bred dairy cows were randomly assigned to 1 of the 3 grazing treatments (10 cows/treatment). Treatments were balanced for average daily milk production before the experiment (23.4 ± 3.4 kg of milk/d; 1.0 ± 0.2 kg of fat/d; 0.7 ± 0.1 kg of protein/d), DIM (59 ± 17 d), age (4.4 ± 2.8 yr), and BW (452 ± 52 kg).

Before grazing during the experimental period, 200 compressed pasture height measurements were recorded in areas to be grazed using a calibrated RPM. There is a strong correlation between pasture yield and pasture height measured by RPM. O'Donovan et al. (2002) concluded that a linear regression of actual pasture yield (i.e., a cut sample) on pasture height (i.e., as derived from a RPM) explained 94% of the variation in the data, and the residual SD was <10% of the pasture yield. A regression equation was used to relate compressed pasture height (cm) to yield (to ground level) as follows:

Pasture yield (kg of DM/ha) = 250 × compressed pasture height + 500 ($P < 0.001$; $r^2 = 0.76$; $n = 453$; D. J. Donaghy, unpublished data).

Grazing areas were then allotted to each treatment group to ensure a similar daily PA, with a new break offered twice daily. Area allocation (m²/cow) was calculated by multiplying the pasture yield above the preexperimental postgrazing residual by the desired PA (18 kg of DM/cow per day). Areas were fully surrounded by electric fences to prevent back grazing, and cows had access to water in their respective treatment areas. Pre- and postgrazing compressed pasture height measurements ($n = 150$) were made daily in each grazing area.

Treatment groups grazed their respective areas for 10 d during the experimental period. Before grazing, representative pasture samples (500 g) were cut from each area to the preexperimental postgrazing height. Following blending, one subsample (100 g) was weighed and dried at 60°C to constant weight to estimate DM content. This subsample was then ground to pass through a 1-mm sieve (Christy Lab Mill, Suffolk, UK) and analyzed for CP, NDF, OM digestibility (OMD), and ME content using near infrared spectroscopy (Corson et al., 1999). A further subsample (30 g) was separated into perennial ryegrass leaf and stem/pseudostem, white clover, weeds, other grasses, and

dead material and dried at 60°C to constant weight to determine botanical composition. The nutritive characteristics and botanical composition of the pasture offered are presented in Table 1.

Individual milk yields were recorded daily, and p.m. and a.m. milk samples were collected from individual cows on each of the last 2 d of the treatment period. Fat, protein, and lactose concentrations of milk were determined by MilkoScan 133 (Foss Electric, Hillerød, Denmark). Mean group DMI was estimated as the product of the difference between the pre- and postgrazing pasture yield and area grazed, as outlined by Roche et al. (1996).

All data were analyzed using the statistical procedures of GenStat 10 (VSN International Ltd., Hemel Hempstead, UK). Data were analyzed by ANOVA with cow as the random effect and linear contrasts of postgrazing residual height as a fixed effect. Treatment effects on estimated group DMI were compared with sampling day as a replicate. Preexperimental data were included as a covariate in the analysis of milk production and composition.

Pasture accumulation since the previous grazing increased linearly with postgrazing height ($P < 0.001$). This is consistent with previous research (Lee et al., 2008), but the positive effect of grazing residual on subsequent pasture growth has been shown to be transitory, with postgrazing heights in the range investigated here having no effect on pasture grown over several grazings. Altering the size of the grazing area ($P < 0.01$; 137, 112, and 89 m²/cow per d for low, medium, and high, respectively) ensured a similar PA, both above the preexperimental postgrazing residual (16.9 ± 3.07, 17.3 ± 2.11, and 17.2 ± 3.71 kg of DM/cow per d for low, medium, and high, respectively) and to ground level (37.8 ± 7.41, 37.3 ± 5.71, and 34.7 ± 7.27 kg of DM/cow per d for low, medium, and high, respectively).

Postgrazing heights during the experiment were greater than during the preexperimental period, but a similar difference between treatments was maintained (4.8, 6.2, and 6.9 cm for low, medium, and high, respectively). Therefore, despite grazing to different postgrazing heights, pasture disappearance per daily grazing area was similar across treatments (estimated DMI; 14.7 ± 3.0, 14.7 ± 1.6, and 15.0 ± 2.9 kg of DM/cow per d for low, medium, and high, respectively).

In comparison with other studies that reported a positive effect of postgrazing height on milk production (Mayne et al., 1987; Gibb et al., 1997; Maher et al., 2003), a negative effect was observed in the current study, with milk yield declining ($P < 0.05$) with increasing postgrazing height (Table 2). Milk protein percent increased with increasing postgrazing height, but yield of milk constituents or FCM were not affected

Table 1. Mean ($\pm$ SD) nutritive characteristics and botanical composition of pasture offered to dairy cows during the experimental period following grazing to low, medium, or high postgrazing heights

Item	Postgrazing height ¹		
	Low	Medium	High
Nutritive characteristics ²			
CP, % of DM	22.3 (2.0)	22.7 (1.7)	22.5 (1.9)
NDF, % of DM	45.5 (3.7)	45.4 (2.0)	44.1 (3.4)
OM digestibility, % of DM	85.0 (3.4)	85.8 (3.3)	87.1 (4.0)
ME, MJ/kg of DM	13.0 (0.6)	13.2 (0.6)	13.4 (0.7)
Botanical composition, % DM			
Ryegrass leaf	70.3 (9.1)	68.0 (9.9)	72.6 (9.4)
Ryegrass pseudostem	12.3 (6.8)	12.4 (3.3)	17.1 (12.6)
White clover	1.4 (2.3)	2.0 (2.3)	0.7 (0.7)
Weeds and other grasses	14.5 (10.4)	14.9 (5.3)	8.5 (9.7)
Dead matter	1.5 (0.9)	2.7 (1.3)	1.0 (0.4)

¹Dairy cows grazing pastures to 4.8 (low), 6.2 (medium), or 6.9 (high) cm compressed postgrazing height during the experimental period.

²Of pasture above the preexperimental postgrazing height.

by treatment. Results indicate only a minor effect of postgrazing height on milk production when PA was similar across treatments.

In previous studies, the different postgrazing heights resulted from offering different PA from homogeneous pastures. Therefore, the lower milk production was probably a result of cows being offered less pasture, and consequently eating less (due to lower PA, but also reduced bite mass as cows grazed lower to the ground; Bargo et al., 2003). Due to the reduced PA, it is also likely that cows would have grazed lower than the previous postgrazing height, thus consuming older, and

less nutritious, pasture. This reduced DMI and poorer quality feed (lower digestibility, higher fiber; Holmes and Hoogendoorn, 1983; Michell and Fulkerson, 1987; Holmes et al., 1992) would be expected to reduce milk production (Holmes et al., 2002), and are more likely the contributing factors toward the decline in milk production following intensive grazing (<5 cm postgrazing height; Mayne et al., 1987; Gibb et al., 1997; Maher et al., 2003), rather than the assumption that severe grazing directly reduced milk production per se.

In comparison, in the current study when cows were offered the same PA above the preexperimental post-

Table 2. The effect of postgrazing pasture height¹ on average daily milk production and milk composition of dairy cows offered a similar pasture allowance

Item	Postgrazing height ¹			SED	<i>P</i> -value, linear
	Low	Medium	High		
Production, kg/d					
Milk	23.4	23.1	20.8	1.15	<0.05
FCM	23.5	24.7	21.3	1.37	0.13
Fat	0.95	1.02	0.87	0.069	0.25
Protein	0.73	0.74	0.68	0.036	0.21
Lactose	1.15	1.16	1.07	0.062	0.27
Composition, %					
Fat	4.09	4.36	4.22	0.227	0.57
Protein	3.10	3.18	3.30	0.076	<0.05
Lactose	5.00	5.02	5.05	0.075	0.51

¹Dairy cows grazing pastures to 4.8 (low), 6.2 (medium), or 6.9 (high) cm compressed postgrazing height during the experimental period.

grazing residual, the yield of FCM or milk components was not affected by the lower postgrazing height, supporting the hypothesis that the negative effect of postgrazing height in the previous studies was PA-related. Furthermore, consistent with the presented results, Holmes et al. (1992) observed an increase in per cow production when cows grazed pastures of a lower pregrazing mass to a lower postgrazing residual when PA was similar across treatments. The increase in milk production in that study was a result of improved nutritive value of the pasture fed. However, pastures with a low pregrazing mass were created by shorter regrowth periods during the preceding winter. This may explain the improved nutritive value in the low grazing residual treatments in that study when compared with the current study, where only pasture that had grown since the previous rotation was being consumed, and that was likely to be of comparable nutritive value to the other treatments because it was of similar age.

The reason for the increase in milk yield with decreasing postgrazing height in the current study is not clear. Severe defoliation has been reported to decrease proportions of stem and dead material, thereby reducing the fiber content and increasing the digestibility and ME content of the pasture (Holmes and Hoogendoorn, 1983; Michell and Fulkerson, 1987; Holmes et al., 1992). However, these effects were not observed in the current study, possibly because it was too early in the season, or just that it was conducted over a single grazing rotation.

Data from the current study indicate that pastures can be grazed to a low postgrazing residual pasture height during spring without adversely affecting milk production. However, further research is required to fully understand the impact of low postgrazing heights on milk production over multiple rotations.

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REFERENCES

- Bargo, F., L. D. Muller, E. S. Kolver, and J. E. Delahoy. 2003. Invited Review: Production and digestion of supplemented dairy cows on pasture. *J. Dairy Sci.* 86:1–42.
- Corson, D. C., G. C. Waghorn, M. J. Ulyatt, and J. Lee. 1999. NIRS: Forage analysis and livestock feeding. *Proc. N.Z. Grassl. Assoc.* 61:127–132.
- Dalley, D. E., J. R. Roche, C. Grainger, and P. J. Moate. 1999. Dry matter intake, nutrient selection and milk production of dairy cows grazing rainfed perennial pastures at different herbage allowances in spring. *Aust. J. Exp. Agric.* 39:923–931.
- Dillon, P., J. R. Roche, L. Shalloo, and B. Horan. 2005. Optimising financial return from grazing in temperate pastures. Utilisation of grazed grass in temperate animal systems. *Proc. Satellite Workshop XX Int. Grassl. Congr.*, July 2005, Cork, Ireland:131–147.
- Fulkerson, W. J., and D. J. Donaghy. 2001. Plant-soluble carbohydrate reserves and senescence—Key criteria for developing an effective grazing management system for ryegrass-based pastures: A review. *Aust. J. Exp. Agric.* 41:261–275.
- Gibb, M. J., C. A. Huckle, R. Nuthall, and A. J. Rook. 1997. Effect of sward surface height on intake and grazing behaviour by lactating Holstein Friesian cows. *Grass Forage Sci.* 52:309–321.
- Holmes, C. W., I. M. Brookes, D. J. Garrick, D. D. S. MacKenzie, T. J. Parkinson, and G. F. Wilson. 2002. Principles of nutrition and feeding. Pages 209–313 in *Milk production from pasture: Principles and practices*. D. Swain, ed. Massey Univ., Palmerston North, NZ.
- Holmes, C. W., and C. J. Hoogendoorn. 1983. Some effects of grazing management in early lactation, and of topping on the growth and quality of pasture. Pages 36–43 in *Dairy farming Ann. Massey Univ.*, Palmerston North, NZ.
- Holmes, C. W., C. J. Hoogendoorn, M. P. Ryan, and A. C. P. Chu. 1992. Some effects of herbage composition, as influenced by previous grazing management, on milk production by cows grazing on ryegrass/white clover pastures. 1. Milk production in early spring: Effects of different regrowth intervals during the preceding winter period. *Grass Forage Sci.* 47:309–315.
- Le Du, Y. L. P., J. Combellas, J. Hodgson, and R. D. Baker. 1979. Herbage intake and milk production by grazing dairy cows. 2. The effects of level of winter feeding and daily herbage allowance. *Grass Forage Sci.* 34:249–260.
- Lee, J. M., D. J. Donaghy, and J. R. Roche. 2007. The effect of grazing severity and fertiliser application during winter on herbage regrowth and quality of perennial ryegrass (*Lolium perenne* L.). *Aust. J. Exp. Agric.* 47:825–832.
- Lee, J. M., D. J. Donaghy, and J. R. Roche. 2008. Effect of defoliation severity on regrowth and nutritive value of perennial ryegrass (*Lolium perenne* L.) dominant swards. *Agron. J.* 100:308–314.
- Macdonald, K. A., J. W. Penno, J. A. S. Lancaster, and J. R. Roche. 2008. Effect of stocking rate on pasture production, milk production and reproduction of dairy cows in pasture-based systems. *J. Dairy Sci.* 91:2151–2163. In press.
- Maher, J., G. Stakelum, and M. Rath. 2003. Effect of daily herbage allowance on the performance of spring-calving dairy cows. *Ir. J. Agric. Food Res.* 42:229–241.
- Mayne, C. S., R. D. Newberry, S. C. F. Woodcock, and R. J. Wilkins. 1987. Effect of grazing severity on grass utilization and milk production of rotationally grazed dairy cows. *Grass Forage Sci.* 42:59–72.
- Michell, P., and W. J. Fulkerson. 1987. Effect of grazing intensity in spring on pasture growth, composition and digestibility, and on milk production by dairy cows. *Aust. J. Exp. Agric.* 27:35–40.
- Nicol, A. M., and G. B. Nicoll. 1987. Pastures for beef cattle. Pages 119–132 in *Livestock feeding on pasture*. Occ. Pub. No. 10. A. M. Nicol, ed. N.Z. Soc. Anim. Prod., Hamilton, New Zealand.
- O'Donovan, M., P. Dillon, M. Rath, and G. Stakelum. 2002. A comparison of four methods of herbage mass estimation. *Ir. J. Agric. Food Res.* 41:17–27.
- Roche, J. R., P. Dillon, S. Crosse, and M. Rath. 1996. The effect of closing date of pasture in autumn and turnout date in spring on sward characteristics, dry matter yield and milk production of spring-calving dairy cows. *Ir. J. Agric. Food Res.* 35:127–140.
- Stakelum, G. 1986. Herbage intake of grazing dairy cows. 2. Effect of herbage allowance, herbage mass and concentrate feeding on the intake of cows grazing primary spring grass. *Ir. J. Agric. Res.* 25:41–51.

- Stakelum, G., and P. Dillon. 1990. Influence of sward structure and digestibility on the intake and performance of lactating and growing cattle. Pages 30–42 in *Management Issues for the Grassland Farmer in the 1990s*. Occ. Pub. No. 25. C. S. Mayne, ed. Br. Grassl. Soc., Hurley, UK.
- Stockdale, C. R. 2000. Levels of pasture substitution when concentrates are fed to grazing dairy cows in northern Victoria. *Aust. J. Exp. Agric.* 40:913–921.
- Wales, W. J., P. T. Doyle, and D. W. Dellow. 1998. Dry matter intake and nutrient selection by lactating cows grazing irrigated pastures at different pasture allowances in summer and autumn. *Aust. J. Exp. Agric.* 38:451–460.
- Wales, W. J., P. T. Doyle, C. R. Stockdale, and D. W. Dellow. 1999. Effects of variations in herbage mass, allowance, and level of supplement on nutrient intake and milk production of dairy cows in spring and summer. *Aust. J. Exp. Agric.* 39:119–130.