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The effect of target postgrazing height on sward clover content, herbage yield, and dairy production from grass-white clover pasture

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ABSTRACT

White clover (*Trifolium repens*) is an important legume for grazed grassland that can increase the profitability and environmental sustainability of milk production. Previous experiments on mown grass-clover plots suggest that low postgrazing heights (PGH) can increase sward clover content and herbage production. However, this has not been tested in actual strip or rotational grazing systems with dairy cows. Furthermore, lowering PGH in grass-only swards (typically perennial ryegrass without white clover) has previously been associated with reduced milk yields per cow. The objective of this experiment was to investigate the effect of PGH by dairy cows on clover content, herbage production, and milk production from strip-grazed grass-white clover swards in Ireland. Three target PGH treatments of 4, 5, and 6 cm were in place for entire grazing seasons (February to November) for 3 consecutive years (2007 to 2009). Each treatment had a mean of 21 Holstein-Friesian dairy cows that strip-grazed a mean annual area of 10.2 ha. Postgrazing height was measured twice a day with a rising plate meter, and cows were moved to the next strip once the target PGH was reached. Annual fertilizer nitrogen input was 90 kg of N/ha for each treatment. The PGH treatment did not significantly affect annual milk yield (6,202 kg/cow), solids-corrected milk yield (6,148 kg/cow), fat, protein, or lactose yields (265, 222, and 289 kg/cow, respectively), cow liveweight (592 kg) or body condition score (3.01). The PGH treatment also had no significant effect on sward white clover content (196 g/kg). However, herbage production of both grass and clover were significantly higher with the 4-cm PGH treatment compared with the 6-cm treatment. Mean annual herbage yields were 11.1, 10.2, and 9.1 t of organic matter (OM)/ha for the 4-, 5-, and 6-cm PGH treatments, respectively. The lower herbage production in the 6-cm PGH treatment resulted in lower annual silage production, greater housing requirements, and a substantially higher net silage deficit (−1,917 kg of OM/cow) compared with the 5- or 4-cm treatments (−868 and −192 kg of OM/cow, respectively). Grazing to a PGH of 4 cm is therefore recommended for grass-white clover swards.
Key words: postgrazing height, white clover, perennial ryegrass, milk yield

INTRODUCTION

White clover (*Trifolium repens*) facilitates biological nitrogen fixation (**BNF**) through its association with *Rhizobium* bacteria and can thereby reduce fertilizer N requirements of grassland for dairy production (Gylfadóttir et al., 2007; Humphreys et al., 2009; Del Prado et al., 2011). White clover is most commonly grown in association with perennial ryegrass (*Lolium perenne*), and increasing its content in herbage can improve sward nutritive value, herbage intake rates, and milk production per cow (Harris et al., 1998; Dewhurst et al., 2009; Kleen et al., 2011). Replacing fertilizer N use with white clover-based BNF can also improve economic performance at the farm level (Doyle and Bevan, 1996; Falconer et al., 2011; Humphreys et al., 2012). This is particularly so in recent years because of the large increase in fertilizer N price relative to milk price (World Bank, 1990–2012). White clover can also have important environmental benefits such as increased biodiversity (Power and Stout, 2011) and reduced greenhouse gas emissions (Li et al., 2011) for dairy production from grazed grassland.

One of the main challenges in achieving the above benefits from white clover is maintaining effective sward clover content (>300 g/kg) within the sward from year to year (Frame and Laidlaw, 1998; Rochon et al., 2004). Previous experiments on mown, small-scale grass-clover plots have shown that lowering defoliation height can increase clover content and clover herbage production (Frame and Boyd, 1987; Acuña and Wilman, 1993; Phelan et al., 2009). The beneficial effect of lowering defoliation height on sward clover content is generally attributed to reduced shading of the clover growing points by grass (Thompson, 1993; Héraut-Bron

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et al., 2001; Christophe et al., 2006). As a result, low postgrazing heights (**PGH**) are often recommended for grass-clover swards. However, the effect of PGH on clover content in grass-clover swards has not been investigated in actual strip or rotational grazing systems for dairy production over entire grazing seasons. Furthermore, daily herbage allowance (**DHA**) experiments on grass-only swards have found that lower PGH can be associated with lower milk yields per cow and lower milk fat, protein, or lactose concentrations (Le Du et al., 1979; Maher et al., 2003; Curran et al., 2010).

The objectives of this experiment were to measure the effects of imposing a target PGH of 4, 5, or 6 cm on sward white clover content, herbage production, and milk production from grass-clover swards in a strip-grazing system with dairy cows over several grazing seasons. It was hypothesized that lowering PGH would (1) increase sward clover content, which would increase BNF and herbage production, but (2) also reduce milk yield per cow.

MATERIALS AND METHODS

Experimental Area

This experiment was conducted from January 2007 to December 2009 at Solohead Research Farm in Ireland (52°51′N, 08°21′W, 95 m above sea level). The soils of the farm are 90% poorly drained gleys and 10% gray-brown podzolics with a depth ranging from 5 to 10 m, overlaying Devonian sandstone. Drainage is impeded, which contributes to waterlogged conditions under high rainfall. The soil has a clay-loam texture of 36% sand and 28% clay in the A1 horizon. Soil organic matter content was 13% and soil pH was 6.6 before the experiment. The land has been under permanent grassland for over 50 yr but was reseeded with perennial ryegrass between 1985 and 1995 and oversown with white clover between 2001 and 2006, as described by Humphreys et al. (2009). The botanical composition of the swards (in g/kg of herbage DM, sampled in September 2008) was found to be predominantly perennial ryegrass (approximately 750 g/kg) and white clover (approximately 200 g/kg). Unsown species were primarily *Taraxacum officinale* (dandelion), *Ranunculus repens* (creeping buttercup), *Bellis perennis* (daisy), and *Plantago lanceolata* (ribwort plantain), which accounted for less than 50 g/kg in total.

Soil temperature (°C at depth of 10 cm) and rainfall amounts (mm) were measured every 30 min at an automatic meteorological station on the farm (Campbell Scientific Ltd., Loughborough, UK). The experimental area was 40.8 ha in 2007 and 25.5 ha in both 2008 and 2009.

Experimental Design and Grazing Management

The experiment was a complete randomized block design consisting of 3 treatments that were target PGH of 4, 5, or 6 cm imposed for entire grazing seasons (February to November) over 3 consecutive years (2007 to 2009).

The experimental area was divided into 6 sections according to soil type and drainage status in January 2007. One paddock from each section was randomly assigned to PGH treatment and remained under that treatment until the end of the experiment in December 2009. Paddock size ranged from 1.46 to 3.30 ha^2 in 2007 (mean = 2.27 ha^2) and from 0.94 to 1.97 ha^2 in both 2008 and 2009 (mean = 1.42 ha^2). The total stocking rate in each treatment was 1.99 cows/ha in 2007 and 2.12 cows/ha in 2008 and 2009.

Cows were turned out to graze approximately 3 d after calving in mid-February and remained at pasture until they were dried off and housed full-time at the end of November. Exceptions were made when ground conditions were too wet (soil moisture >60%) or when herbage supply was too low, which generally occurred when herbage growth rates were below demand and pregrazing herbage mass was <500 kg of DM/ha (above PGH). On such occasions, cows were housed at night and fed grass-clover silage ad libitum.

Each treatment was under strip-grazing management, with approximately 0.25 to 0.50 of each paddock allocated each time. The PGH (cm above the soil surface) was measured twice per day from 50 drops with a Filips rising plate meter (www.grasstec.ie). Cows were moved to the next pasture area once the target PGH was achieved, and a back-fence was used to stop animals returning to previously grazed areas.

Slurry produced during housing was stored together and reapplied to each treatment equally during the following grazing season using regulatory protocols (European Communities Good Agricultural Practice for Protection of Water Regulations, 2009, S.I. No. 101) and an umbilical system with downward-facing splash plate. Each treatment received annual mineral fertilizer N input of 90 kg/ha, applied in the form of urea between February and April and as calcium ammonium nitrate (CAN) in May of each year. These were the only forms of synthetic fertilizer N used in this study, and no fertilizer N was applied during the remainder of the growing season.

Excess herbage production was identified throughout the experiment and removed for silage production. These areas were selected when herbage growth rates exceeded demand, resulting in pregrazing herbage mass >2,000 kg of DM herbage (above PGH) per hectare. Such areas were generally closed from grazing between