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The effect of temperate or tropical pasture grazing state and grain-based concentrate allocation on dairy cattle production and behavior

C. E. F. Clark,*[1] R. Kaur,* L. O. Millapan,† H. M. Golder,‡ P. C. Thomson,* A. Horadagoda,*[2] M. R. Islam,* K. L. Kerrisk,* and S. C. Garcia*

*Dairy Science Group, Sydney Institute of Agriculture, School of Life and Environmental Sciences, Faculty of Science, University of Sydney, Camden, NSW 2570, Australia
†Department of Animal Production, Faculty of Agronomy, University of Buenos Aires, Buenos Aires 1417, Argentina
‡Scibus, Camden, NSW 2570, Australia

ABSTRACT

Grain-based concentrate (GBC) supplement is of high cost to dairy farmers as a feed source as opposed to grazed pasture. Milk production response to GBC is affected by the composition and nutritive value of the remainder of the diet, animal factors, and interactions between forage type and level of GBC. In grazing systems, dairy cattle encounter contrasting pasture states, primarily because the social structure of the herd affects the timing of when each animal accesses a paddock after milking as a result of a relatively consistent cow milking order. However, the effect of feed management, namely pasture state and GBC allocation, on dairy cattle production and behavior is unknown. We examined the effect of varying GBC allocation for dairy cattle grazing differing states of kikuyu grass (*Pennisetum clandestinum*, a tropical pasture species; experiment 1) and annual ryegrass (*Lolium multiflorum* L., a temperate pasture species; experiment 2) on dry matter intake, milk production and composition, and grazing behavior. For each experiment, 90 lactating dairy cattle were randomly allocated to 2 consistent (fresh–fresh and depleted–depleted) and 2 inconsistent (fresh–depleted and depleted–fresh pasture state treatments (defined as sequences of pasture state allocation for the morning and afternoon grazing events) and 3 GBC treatments [2.7, 5.4, and 8.1 kg of dry matter (DM)/cow per day], giving 12 treatment combinations for each experiment. The duration of each experiment was 14 d, with the first 7 d used as adaptation to treatment. In each experiment, 3 cattle were selected from each of the 12 pasture type × GBC treatment groups within the experimental herd to determine herbage intake and total DM digestibility using the n-alkanes method (n = 36). There was no interaction between kikuyu grass or ryegrass pasture state and GBC level for intake, digestibility, or milk yield or components. Dairy cattle offered fresh–fresh and depleted–fresh ryegrass produced 9% more milk yield, in line with greater pasture intakes, compared with fresh–depleted and depleted–depleted pasture states. Dairy cattle offered fresh–fresh kikuyu grass had 8% more milk yield and 14% more milk protein yield than other pastures states, but there was no effect of pasture state on milk composition. Milk yield increased with GBC level for both pasture species (∼0.7–0.8 kg of milk/kg of DM GBC) as GBC level increased from 2.5 to 5.4 kg of DM/cow per day. There was a poor response (0.3 kg of milk/kg of DM GBC), and no response, when GBC levels increased from 5.4 to 8.1 kg of DM/cow per day for kikuyu grass and ryegrass, respectively, in line with pasture DMD. Time spent grazing, lying, and ruminating were not associated with kikuyu grass pasture state, GBC, or their interaction. Despite this, there was a linear increase in grazing time in the afternoon coinciding with a linear decrease in lying and rumination time for both kikuyu grass and ryegrass pasture. Together these findings reveal the effect of pasture state and GBC allocation on dairy cattle production and behavior. Tailoring GBC allocation to the state of pasture accessed by cattle appears unwarranted, but there is an opportunity to alter the timing of pasture access to increase herd-level milk production efficiency.

Key words: precision feeding, milking order, pasture stratum, grain

INTRODUCTION

Pasture is the predominant feed for Australian dairy herds, and perennial ryegrass (*Lolium perenne*) is the main pasture species in southern (temperate) Australia. On the subtropical east coast, kikuyu grass

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[1]Corresponding author: cameron.clark@sydney.edu.au
[2]Deceased.

(*Pennisetum clandestinum*) is the predominant pasture species (Garcia et al., 2014). The seasonality of rainfall and temperature in these dairying areas affects pasture growth (Garcia and Fulkerson, 2005), creating times of feed surplus and deficit that are most commonly addressed by conserving surplus pasture (as hay or silage) and supplementing cattle with grain-based concentrate (**GBC**; Garcia and Fulkerson, 2005). Currently, supplementary feeds are the largest cost on Australian dairy farms at 30% of the total cash costs (Dairy Australia, 2014). This high proportion of costs attributed to supplementary feed is likely to increase over time as grain costs over the past 20 yr have increased at 3 times the rate of milk price (Dairy Australia, 2014). Thus, there is a need for dairy farmers that supplement GBC to do so efficiently and strategically to maintain profitability.

Efficient, profitable supplementation of GBC needs to consider not only the amount of pasture on offer to dairy cattle but also the characteristics of this feed, as the milk production response to GBC supplementation differs according to pasture type (Stockdale, 1997). Even within pasture types, the chemical composition of the plant varies between strata, with the top fraction typically containing more CP and less fiber than lower plant fractions (Delagarde et al., 2000; Scott et al., 2014). Dairy cattle modify their grazing behavior according to these characteristics, ingesting swards in successive layers from the tip of the youngest leaf progressively down the sward until reaching the residual biomass level (Wade and Carvalho, 2000; Scott et al., 2014). As cattle have a consistent milking order and typically access pasture over the duration of the milking session, the first cattle moving to an allocation of fresh pasture are offered feed of greater nutritive value compared with those arriving last (Scott et al., 2014) and typically produce a greater milk yield (Margetínová et al., 2003; Botheras, 2006). Although these studies linked milking order with milk yield from retrospective data, the experimental design precluded drawing a definitive association between the nutritive value of the pasture state accessed at varying stages of depletion and milk production, milk composition, and animal behavior.

We determined the effect of both annual ryegrass (*Lolium multiflorum* L.) and kikuyu grass (*Pennisetum clandestinum*) pasture grazing states, and their interaction with GBC, on milk production, milk composition, and feeding-associated behavior. It was hypothesized that milk production and milk composition would be greater both for cattle offered a greater allocation of GBC and for those consistently accessing undepleted upper fractions of pasture compared with those offered depleted lower fractions of pasture. It was also hypothesized that cattle offered depleted pasture would have a greater response to GBC than those offered undepleted pasture states.

MATERIALS AND METHODS

Animals and Experimental Design

Experiment 1 was conducted in January and February (summer) with cattle offered kikuyu grass pasture, and experiment 2 was conducted in October (spring) with cattle offered annual ryegrass pasture. Use of animals was approved by the University of Sydney's Animal Ethics Committee (project no. 5926). In both experiments, 90 mid-lactation multiparous Holstein-Friesian cattle were sourced from the Corstorphine dairy research herd (University of Sydney, Camden, Australia). Cattle were allocated to treatments by stratified randomization based on BW, milk yield, and milk fat and protein concentration. In the pre-experimental period, cattle grazed as a single herd on pasture with 5.4 kg of DM/d GBC supplementation for 7 d to allow uniform distribution of groups for milk yield and live weight. At the start of the experimental period for experiment 1, cattle averaged (mean ± SD) 64 ± 20.9 mo of age, weighed 619 ± 66.7 kg, were 225 ± 63.2 DIM, and produced 21 ± 4.2 kg of milk/d. At the start of the experimental period for experiment 2, cattle averaged 62 ± 20.7 mo of age, weighed 575 ± 61.2 kg, were 211 ± 37.9 DIM, and produced 26 ± 4.7 kg of milk/d.

Treatments and Measurements

The cattle received 1 of 3 GBC allocations daily (2.7, 5.4, or 8.1 kg of DM/cow per day) and 4 treatments of pasture state or fraction in a 3 × 4 factorial arrangement: fresh–fresh (**FF**), depleted–depleted, (**DD**), fresh–depleted (**FD**), and depleted–fresh (**DF**) as sequences of morning and afternoon allocations, respectively (Table 1). The GBC was a grain-based pelleted supplement (Vella Stock Feeds, Glendenning, NSW, Australia; 93% DM, 16% protein, and 20% NDF) that was offered to the cattle in 2 equal amounts after the morning and afternoon milkings. All GBC offered was consumed.

In each experiment, cattle grazed as 2 separate herds—45 cattle in fresh (not grazed) pasture allocations and 45 in depleted (grazed) pasture allocations—for the duration of each experimental period and were removed from the paddocks for morning (0500 h) and afternoon (1500 h) milkings. Fresh pasture that was offered to cattle became the subsequent depleted treatment for the following day. Cattle were sorted to their respective treatment groups through the automatic drafting gates at the milking parlor.