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Controlling herbage allowance and selection of cow genotype improve cow-calf productivity in Campos grasslands

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ABSTRACT

An experiment was conducted to determine the effect of herbage allowance and cow genotype on herbage and animal responses. High (Hi) and Low (Lo) herbage allowance (4.9 and 2.9 ± 0.14 kg of DM/kg of cattle BW, respectively) and pure (Pu, Hereford and Angus) and crossbred (Cr, F1 crosses) cow genotypes were compared in terms of herbage traits, stocking rate, cow BCS, energy intake, and calf BW at weaning during 2 cow-calf cycles (−240 to +120 d postpartum). Herbage height (5.5 vs. 3.5 ± 0.18 cm, mean ± SE) and herbage accumulation (15.0 vs. 12.5 ± 1.1 kg of DM/ha per d) were greater ($P > 0.01$) for Hi than Lo, whereas stocking rate did not differ ($P > 0.2$) between Hi and Lo (382 vs. 398 ± 7 kg of BW/ha, respectively). Cow BCS was greater ($P > 0.05$) in Hi than Lo (4.3 vs. 3.9 ± 0.02) and in Cr than Pu cows (4.2 vs. 4.0 ± 0.04). Calf BW at weaning was greater (20 and 10 kg) for Hi than Lo and for Cr than Pu cows, but energy intake (473 vs. 455 ± 4.6 kJ/kg of $BW^{0.75}$ per d) was greater ($P > 0.05$), only in Hi compared with Lo cows. Modeling BCS evolution during the cow-calf cycle confirmed that Hi herbage allowance and Cr cows improved energy balance and cow-calf biological efficiency. This information can be used to improve profitability and mitigate weather variability effects on Campos grassland livestock systems.

Key words: beef cow, body condition, herbage mass, biological efficiency

INTRODUCTION

The control of grazing intensity through the management of stocking rate is an important tool for regulating the amount of solar energy captured and converted into beef production (Briske and Heitschmidt, 1991). In environments with large variation in herbage production due to seasonal differences in rainfall or temperature, the optimal stocking rate to reach a specific performance target varies widely among seasons and years (Mott, 1960; Wheeler et al., 1973; Aiken, 2016). Within this context, herbage allowance (**HA**), defined as kilograms of herbage DM per kilogram of animal BW (Sollenberger et al., 2005; Allen et al., 2011), may be more useful than stocking rate alone for managing the grazing process. For Campos grassland, manipulation of HA with growing steers from 4 to 12% of the animal BW increased beef production from 80 to 145 kg of BW/ha and herbage production from 10 to 13 kg/ha per d (Maraschin et al., 1997).

Cow-calf production is a long-term and energetically inefficient process within the context of the Campos's livestock systems (Do Carmo et al., 2016). Matching cow requirements and energy intake in grazed ecosystems with seasonal variability in herbage production and nutritive value is one of the main challenges to intensification of Campos's livestock (Tittonell et al., 2016). Grazing management based on HA could improve the economic and environmental response of beef cow-calf systems (Do Carmo et al., 2016). However, knowledge is limited of the HA–BCS relationship and the nature of interactions among herbage growth, stocking rate, and productivity per animal or hectare for cow-calf responses (Claramunt et al., 2017).

Previous reports have shown that reciprocal crossbreeding between Angus and Hereford (F1), the most common breeds in Campos, increased kilograms of calf weaned per cow exposed and biological efficiency over purebreds (Morris et al., 1987; Cundiff, 2004). However, we do not have grazing experiments evaluating the effect of HA and cow genotype in interaction with year (different climate conditions) on productivity or efficiency of energy use. Grazing experiments that evaluated the interaction of HA and cow genotype and year are of primary importance to assess the effect of HA and cow genotype on stocking rate, herbage growth, cow adaptability, and productivity in a variable climate. This information emphasizes the role of grazing experiments as a basis for ecological intensification in beef cow-calf systems on Campos grassland or other

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subtropical-subhumid grassland (Gunter and Cole, 2016). The objective was to study the effect of HA and cow genotype on herbage mass and accumulation, stocking rate, cow BCS and BW, calf BW at weaning, and biological efficiency during 2 cow-calf cycles.

MATERIALS AND METHODS

Experimental Site, Design, and Treatments

The experiment was conducted on 95 ha of Campos grassland located at the Prof. Bernardo Rosengurtt Experimental Station, School of Agronomy, Uruguay (32°35′S, 54°15′W), between August 2007 and March 2010. Average annual rainfall is almost 1,200 mm, and the climate type is classified as Cfa (subtropical, humid, without dry season, where mean temperature in the coldest month is between −3 and 18°C and the warmest is above 22°C) according to Köppen (Panario and Bidegain, 1997). During the first spring-summer (2007–2008, HA establishment and early gestation in cycle 1), rainfall was similar to the long-term average (1961–1990), but a drought occurred during spring-summer 2008 to 2009 (lactation of cycle 1) when rainfall was 55% below the long-term average. In contrast, during the last spring-summer period (2009–2010, lactation of cycle 2), rainfall was 88% above the long-term average (Figure 1A).

The experimental design was a randomized complete block, with 2 blocks that were based on differences in soil characteristics. Block 1 consisted of Hapludalfs and Argiudolls soils and block 2 of Hapluderts and Argiudolls soils. Campos grassland was dominated by "pasto chato" *Axonopus affinis* Chase, *Oxalis* sp., "pasto bolita" *Cyperus* sp., "gramilla" *Cynodon dactylon* (L.) Pers., *Eryngium nudicaule* Lam., *Gaudinia fragilis* (L.) P. Beauv., *Chevreulia sarmentosa* (Pers.) S. F. Blake, *Stipa setigera* (Trin. & Rupr.) Backworth, "pasto horqueta" *Paspalum notatum* Fluegge, and "cola de lagarto" *Coelorhachis selloana* (Hack.) A. Camus [F. Olmos, 2011, formerly with Instituto Nacional de Investigacion Agropecuaria (INIA), Tacuarembo, Uruguay, personal communication], similar to a Campos grassland botanical composition previously reported (Altesor et al., 1998).

Block 1 was 60 ha and block 2 was 35 ha in area. Each block consisted of 4 experimental units (pastures) to which the 2 × 2 factorial combinations of HA [high (**Hi**) and low (**Lo**)] and cow genotype [pure (**Pu**) and crossbred (**Cr**)] treatments were allocated. Herbage allowance, the ratio between herbage mass and stocking rate (kilograms of herbage DM/kilograms of BW; Sollenberger et al., 2005; Allen et al., 2011) was varied with season of the year. Target levels of Hi and Lo HA were 5 and 3 kg of DM/kg of BW during autumn; 3 and 3 kg of DM/kg of BW during winter; and 4 and 2 kg of DM/kg of BW during spring and summer, respectively. Average HA achieved across years was somewhat greater than target levels for both treatments. Herbage allowances were 4.7, 6, 5.6, and 3.3 kg of DM/kg of BW (annual average of 4.9) for Hi and 2.3, 2.8, 3.6, and 2.9 kg of DM/kg of BW (annual average of 2.9) for Lo during spring, summer, autumn, and winter, respectively.

Target levels of HA were based on a previous experiment where maximum per animal and per hectare beef cattle production was achieved at HA of 4 and 2.5 kg of DM/kg of BW, respectively (Piaggio, 1994). Continuous stocking was applied throughout the year (Allen et al., 2011), with stocking rate adjusted monthly starting in August 2007. Adjustments occurred after monthly measurement of herbage mass, which together with animal BW per hectare, was used to calculate HA.

Pasture Measurements

Herbage mass (kg of DM/ha) and height (cm) were quantified monthly using the comparative yield method (Haydock and Shaw, 1975). Approximately 10 reference quadrats were used for calibration, and 100 randomly selected quadrats were rated at each sampling event on each experimental unit. Reference quadrats were 0.25 m^2, and after being assigned a ranking, herbage heights were measured and cut to ground level to quantify herbage mass. The ranking and actual herbage mass data from the reference quadrats were used to develop the equation for predicting herbage mass and height from the average of the ranking of the 100 randomly selected quadrats. Herbage accumulation (kg of DM/ha per d) was quantified from winter 2007 to summer 2010 using portable cages to protect quadrats (0.5 × 0.5 m) from grazing. Herbage accumulation was calculated as dry weight change in kilograms per hectare daily between consecutive sampling dates. Paired quadrats were chosen based on similarity of herbage mass. For one of each pair of quadrats, herbage mass was determined to soil level, and for the other area, a cage was placed to preclude grazing until subsequent harvest at the next sampling date (Mannetje `t, 1978). The difference was considered to be herbage accumulation.

Herbage for laboratory analyses was composited across reference quadrats within an experimental unit and was weighted to represent herbage mass of each reference quadrat sample included. Herbage samples were dried to constant weight at 60°C, weighed, and then double ground using a Wiley mill (Model 4 Thomas-Wiley Laboratory Mill, Thomas Scientific, Swedesboro, NJ) to pass through a 1-mm screen for chemical composition analyses. Analyses of herbage CP (Kjeldahl N percentage × 6.25, AOAC International, 2005) and ADF (Fiber Analyzer 200, Ankom Technology Corporation, Fairport, NY; Van Soest et al., 1991) were performed.

Animals

Animal procedures used in this research were approved by the Animal Experimentation Committee of the Universidad de la República. Experimental animals belonged