

The effect of herbage allowance of *Lotus pedunculatus* cv. Grasslands Maku on winter and spring beef heifer performance

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Abstract

Beef cattle production in Uruguay is limited by heifer mating age when grazing natural pastures. *Lotus pedunculatus* cv. Grasslands Maku is a forage species that was recently introduced to Uruguayan farming systems, with high potential to improve herbage production in acid and low fertility soils. This paper provides information about winter and spring performance of Hereford x Angus heifers grazing an improved *Lotus pedunculatus* cv. Grasslands Maku pasture when fed at different pasture allowances. Four pasture allowances (3, 5, 10 and 16 kg DM/100 kg animal liveweight/day) from June 30 to October 9 (P1) followed by one pasture allowance of 9 kg DM/100 kg animal liveweight/day from October 9 to November 28 (P2), were assigned to 9 months old Hereford x Angus heifers weighing 129 kg. Measurements included herbage mass, botanical composition, pasture growth rate, sward height and animal liveweight. Liveweight gains were evaluated using a repeated measurement model in time. Pasture mass decreased from 4000 kg DM/ha to 1100, 1050, 1350 and 2000 kg DM/ha for the herbage allowances of 3, 5, 10 and 16% respectively during P1. Legume content at the end of P1 was 550, 400, 700 and 700 kg DM/ha for 3, 5, 10 and 16% of total pasture mass respectively. Herbage mass increased by 328 kg DM/ha per cm sward height ($P < 0.01$, $r^2 = 0.69$, $n = 240$). Mean pasture growth rate in P1 was 21 kg DM/ha/day, being promoted by intensive grazing. In P2, mean pasture growth rate was 58 kg DM/day, increasing when laxly grazed in the previous period (P1). During P1, herbage allowance explained 77% ($P < 0.001$) of liveweight gain, with significant differences ($P < 0.05$) between all treatments (0.20, 0.36, 0.57 and 0.70 kg/heifer/day for allowances of 3, 5, 10 and 16 kg DM/100 kg liveweight/day respectively). In P2, liveweight gains were inversely correlated to the liveweight gains achieved in P1 (1.03, 0.96, 0.85 and 0.76 kg/heifer/day for P1 allowances of 3, 5, 10 and 16 kg DM/100 kg liveweight/day respectively). Feed planning in P1 produced a range of differences of liveweight of 51 kg/heifer and that reduced to 38 kg/heifer in P2. During P1, daily liveweight gains and production/ha were maximized at 16 and 3% of herbage allowance respectively.

Keywords: beef heifer growth, herbage allowance, *Lotus pedunculatus* cv. Grasslands Maku

Introduction

In Uruguay, natural grasslands support beef cattle production systems, with a predominance of summer species (C_4 grasses) and a very low proportion of legumes. In this context, beef cattle production has limitations in heifer mating age (3 years), calving rate (65%), slaughter age (3-4 years) and low annual extraction rates (18-20%) (Berreta *et al.* 1999).

The establishment of oversown pastures in the eastern region of Uruguay, particularly when using mixtures of legumes such as *Trifolium repens* and *Lotus corniculatus*, increase pasture productivity from 3400 to 8600 kg DM/ha (Ayala *et al.* 1996). Recently introduced, *Lotus pedunculatus* cv. Grasslands Maku appeared as one of the most adapted and persistent species to a wide range of poor fertility and acidic soils (Bermúdez *et al.* 2001). Grasslands Maku contains condensed tannins, compounds that reduce ruminant degradation and protein losses, with significant effects on animal performance (Waghorn *et al.* 1998), preventing bloat in cattle at concentrations higher than 5 g/kg DM (Barry & McNabb 1999). Liveweight losses from 90 to 230 g/animal/day are reported when heifers are grazed on native pastures carrying 2 heifers/ha in winter (Quintans *et al.* 1994). The use of strategic areas of *Trifolium repens* and *Lotus corniculatus* mixtures increase winter heifer performance, with liveweight gains of 880-990 g/animal/day when stocked at 2.5 and 2 animals/ha respectively (Scaglia *et al.* 1997).

The effect of herbage allowance on animal performance was measured for improved *Lotus corniculatus* pastures (Soca *et al.* 1993, 1998). However, herbage allowance and animal performance studies with Grasslands Maku have not been explored in beef cattle, hence limiting the design of strategies to improve pasture utilization and increase production and profit.

This paper reports on winter and spring herbage production and the performance of Hereford x Angus heifers grazing an improved Grasslands Maku pasture when fed at different pasture allowances.

Materials and methods

The experiment was carried out from June 30 to November 28, 2001 on a commercial farm located in Rocha at the eastern region of Uruguay, South America ($34^{\circ}4' S$), with shallow soils, using three year old

oversown Grasslands Maku pastures.

The main treatments were four pasture allowances (2.5, 5.0, 7.5 and 10.0 kg DM/100 kg animal liveweight/day) during winter (P1), followed by one common pasture allowance in spring (P2) of 9 kg DM/100 kg animal liveweight/day. In both periods, initial fixed pasture allowances were subsequently adjusted according to pasture mass, pasture growth rate and liveweight change during the experimental period determining final values of pasture allowances. Final values of pasture allowances evaluated in P1 (June 30 to October 9) were 3, 5, 10 and 16 kg DM/100 kg animal liveweight/day for the 2.5, 5.0, 7.5, 10.0 initial allowances, respectively. In P2 (October 9 to November 28), animals from the different treatments were managed together at a pasture allowance of 9 kg DM/100 kg animal liveweight/day.

Paddock area was adjusted at the beginning to achieve the required pasture allowances, and 6 nine months old Hereford x Angus heifers were randomly allocated to different treatments.

Measurements were pasture mass, growth rate, sward height and botanical composition at monthly intervals. Pasture cover was estimated by cutting to ground level 10 quadrats (20 x 50 cm) per treatment. Growth rate was measured using 5 exclusion cages/treatment, using a modification of the trimming cut technique (Lynch 1947), cutting in each cage 4 quadrats (20 x 50 cm), where two received a previous cut at ground level one month before and two were uncut. Sward height was measured taking 4 values with a ruler in each cutting quadrat. Exclusion cages were moved to a new site at each harvest date. Animal liveweight was evaluated at monthly intervals, weighing the animals at the same time in the morning without fasting.

Data were analysed by the PROC MIXED SAS procedures. Means were compared using the Tukey test ($P < 0.05$). Liveweight gain was analysed in each period (P1, P2 and P1+P2) using a repeated measurements in time model:

$$Y_{ij} = \mu + \beta_1 \text{PVI} + \beta_2 \text{Day} + \beta_3 \text{OF} + \beta_4 \text{OF} * \text{Day} + e_{ijk} \text{ where}$$

$$Y_{ij} = \text{Liveweight (kg)}$$

$$\mu = \text{General mean}$$

$$\text{PVI} = \text{Liveweight at the beginning of the experiment (kg)}$$

$$\text{Day} = \text{No. of days of the period}$$

$$\text{OF} = \text{Forage allowance (kg DM/100 kg liveweight/day)}$$

Results and discussion

Pasture performance

The experimental area was closed to grazing from April to June to stockpile forage. Herbage mass at the end of

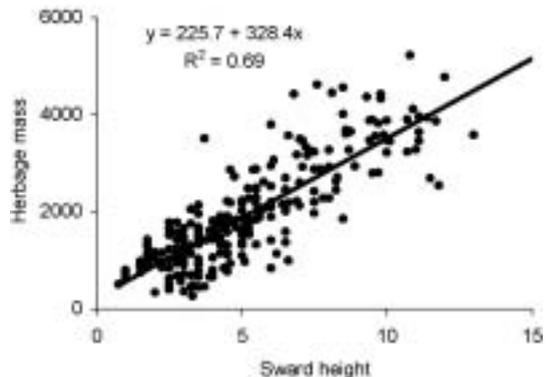
June was 4000 ± 689 kg DM/ha with a Grasslands Maku content of 42% (DM basis). The main companion grasses were *Axonopus affinis*, *Paspalum notatum* and *Paspalum dilatatum*.

The herbage growth rate for the period P1 was 28 ± 6.3 , 23 ± 5.0 , 16 ± 6.2 and 19 ± 6.2 kg DM/ha/day for 3, 5, 10 and 16% herbage allowances respectively. There was a tendency to increase growth rate for the 3% pasture allowance treatment, that suggested a short term effect of intensive grazing in reducing competition of companion grasses and promoting the regrowth based on carbohydrate reserves of Grasslands Maku, with high importance during late autumn to early spring (Sheath 1978). Pasture mass decreased until October 9, when comparisons between the pasture allowances finished (1100 ± 475 , 1050 ± 484 , 1350 ± 384 and 2000 ± 453 kg DM/ha for the herbage allowances of 3, 5, 10 and 16% respectively). Legume content was 550, 400, 700 and 700 kg DM/ha for the 3, 5, 10 and 16% treatments, respectively. Pasture cover reflected grazing intensity and animal preferences for legumes, reaching differences of 82% in total herbage mass and 27% in Grassland Maku content between the extreme comparisons (3 and 16%).

During period P2, when animals grazed all together at the same pasture allowance (9%), the average pasture mass was 1570 ± 347 kg DM/ha with a content of 38% of Grasslands Maku. The herbage growth rate of period P2 was 44 ± 12.6 , 47 ± 16.2 , 61 ± 11.0 and 80 ± 14.3 kg DM/ha/day for 3, 5, 10 and 16% herbage allowances respectively. There is a carryover effect of previous season (P1) having a high regrowth rate in the swards that were more laxly grazed during P1, that reinforce the importance of residual herbage mass for regrowth in the long term (Sheath 1978).

The relationship between sward height and herbage

Figure 1 Relation between sward height (cm) and available herbage mass (DM kg/ha) in a Grasslands Maku pasture during winter and spring.

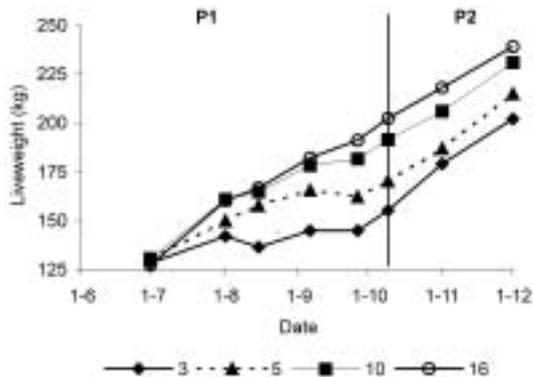


mass was tested, achieving the linear model $y_{P1+P2} = -225.7 + 328.4x$ for the best adjustment ($P < 0.01$, $r^2 = 0.69$, $n = 240$, Figure 1). The plant architecture of Grasslands Maku, with strong rhizomes and branching system, has a high proportion of the biomass distributed in the low strata. The increase in herbage mass per each centimetre is higher than more erect plant types like *Lotus corniculatus*, where mass increased by 120 kg DM/ha per centimetre (Ayala, pers. comm.).

Animal performance

The initial liveweight of heifers was 129 ± 11 kg and increased on average by 46 kg/animal during P1 with extreme values of 20 and 71 kg/animal for pasture allowances of 3 and 16% respectively (Figure 2). In P2, liveweight gains were from 50 to 37 kg/animal for 3 and

Figure 2 Liveweight evolution of heifers grazing Grasslands Maku at four herbage allowances (3, 5, 10 and 16 as a percentage of liveweight) during P1 and maintained at 9% in P2.



16% of pasture allowance during P1, respectively. Final liveweight of heifers was 197 ± 26 , 205 ± 24 , 224 ± 13 and 234 ± 19 kg/animal for 3, 5, 10 and 16% of herbage allowances in P1 respectively.

During P1, the increase in herbage allowance explained 77% of liveweight gain, achieving significant differences ($P < 0.001$) between all treatments (Table 1). The relationship between herbage allowance and liveweight gain was linear, with daily gains of 90 g/day for each 1% increase in herbage allowance ($P < 0.001$). Daily liveweight gain and liveweight production/ha were maximised at 16 and 3% of herbage allowance respectively.

In P2, liveweight gain showed significant differences between treatments ($P < 0.05$), being significantly higher for animals that received herbage allowances of 3 and 5% (P1) than for 10 and 16% (Table 1). There were compensatory liveweight gains in P2, where the lower

Table 1 The effect of herbage allowance (kg DM/100 kg liveweight/day) on daily liveweight gain (kg/heifer/day) of Hereford x Angus heifers grazing Grasslands Maku in P1 (June 30 to October 9), P2 (October 9 to November 28) and P1+P2 (June 30 to November 28).

P1 herbage allowance	P1 stocking rate (heifers/ha)	Liveweight gains		
		P1 ¹	P2 ¹	P1+P2 ¹
3	10	0.20 d	1.03 a	0.45 b
5	4.6	0.36 c	0.96 a	0.51 b
10	3.2	0.57 b	0.85 b	0.63 a
16	2.3	0.70 a	0.76 b	0.70 a

¹ Adjusted minimum square mean of daily liveweight gain. Values in the same column with different letters are significantly different ($P < 0.05$).

P1 allowances resulted in better liveweight performance.

For the whole period (P1+P2), liveweight gains increased with the increase in herbage allowance during P1. The liveweight gains with 10% and 16% of herbage allowance were similar but higher than liveweight gains with 3% and 5% of herbage allowance. The results suggest that 10% of herbage allowance in winter contributed to achieve adequate individual performance and productivity/ha, increasing winter stock in 39% over the 16% allowance treatment (Table 1).

Conclusions

- Results from this trial demonstrated high potential benefits of Grasslands Maku in poor fertile soils, contributing substantially to improved heifer winter performance compared with traditional systems where heifers graze native pastures.
- The highest herbage growth rate in P1 was 28 ± 6.3 kg DM/ha/day for the 3% herbage allowance. A carryover effect was detected in P2, being maximum growth rate of 80 ± 14.3 kg DM/ha/day for 16% herbage allowance during P1.
- During P1, the increase in herbage allowance from 3 to 16% improved heifers liveweight gains from 0.2 to 0.7 kg/day. In P2 there were detected compensatory gains, being the lower the herbage allowances during P1 (3 and 5%), the better P2 daily liveweight gains.
- For the whole period (P1+P2), the best individual animal performance was achieved when high herbage allowances were managed in P1 (10 and 16% of herbage allowances), but the 10% herbage allowance increased winter stock by 39% over the 16% allowance treatment.

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