Grazing management flexibility in pastures subjected to rotational stocking management: herbage production and chemical composition of kikuyu-grass swards

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Abstract. Several recent papers published on tropical pastures have pointed out that under rotational stocking management regrowth should be interrupted when canopy light interception is 95% (LI). Further, these studies have revealed a positive and high correlation between LI and sward height, allowing LI management targets to be defined in terms of sward height. However, there are some indications that lower pre-grazing heights relative to those targets would result in similar leaf accumulation without interfering with sward persistence. The objective of this paper was to verify a possible flexibility of such pre-grazing height targets. A replicated experiment was conducted with treatments corresponding to four pre-grazing height targets (25 cm, corresponding to a canopy light interception of 95%; 20; 15 and 10 cm), which were associated with a single severity of grazing equivalent to removal of 50% of initial height, leaving four post-grazing heights (12.5, 10.0, 7.5 and 5 cm, respectively). Preliminary results indicated that there were no differences in rate of herbage accumulation, herbage yield and crude protein, NDF and ADF contents on swards managed with the pre-grazing targets of 15, 20 and 25 cm. Swards managed with the 10 cm pre-grazing target had the highest contents of CP and lowest contents of NDF and ADF, but herbage accumulation was reduced. Overall, the findings indicate that there may be some flexibility in targets of pre-grazing sward height, provided that defoliation severity is moderate and does not interfere with herbage yield and quality. In that context, targets of pre-grazing sward height defined in terms of canopy light interception would correspond to the *maximum* value of the possible range of values to be used.

Keywords: Herbage mass, canopy light interception, chemical composition, grazing method.

Introduction

The classic work of Bircham and Hodgson (1983), using a continuously stocked, mixed perennial ryegrass x white clover pasture, demonstrated significant flexibility in grazing management. Net herbage accumulation remained stable over a relatively wide range of sward state conditions (*e.g.* sward height or herbage mass), facilitating management and decision making on a farm scale. Under rotational stocking, Korte *et al.* (1982) demonstrated that the ideal moment to interrupt regrowth corresponded to the condition in which sward canopy was intercepting 95% of the photosynthetically active incident radiation (LI). Analogous research with tropical forage grasses revealed similar results, and demonstrated that stem elongation and accumulation was significantly increased beyond this canopy condition, causing degeneration of sward structure and interfering negatively with herbage intake and nutritive value. Further, the results demonstrated a strong positive relationship between sward height and canopy light interception, facilitating the use of sward height as target for controlling the grazing process (Carnevalli *et al.* 2006; Barbosa *et al.* 2007; Da Silva *et al.* 2009; Zanini *et al.* 2012). A common feature of the studies with tropical forage grasses is that they were all conducted using factorial arrangements to define treatments, in which canopy light interception and post-grazing heights corresponded to fixed and pre-defined absolute values, generating treatments characterised by contrasting severities of grazing. On the other hand, some experiments have demonstrated that swards should not be grazed lower than 50% of the pre-grazing height, because of significant reductions in rate of herbage intake with more severe grazing (Fonseca *et al.* 2012; Pérez-Prieto and Delagarde 2012). The results of Barbosa *et al.* (2007) with Tanzania guinea grass revealed that there was no difference in leaf accumulation between the pre-grazing targets of 90 and 95% LI (equivalent to 60 and 70 cm pre-grazing height, respectively), suggesting that there could be some flexibility in the definition of pre-grazing targets; instead of a point there could be a range of possible values to be used. Against that background, the objective of this study was to test the hypothesis that targets of sward height pre-grazing defined in terms of LI would correspond to the maximum value of a range of possible sward heights to be used and that within such range herbage accumulation would be

similar provided that severity of grazing was moderate (not more severe than 50% of the pre-grazing height).

Methods

The study was carried out at UDESC/CAV, Lages, Santa Catarina, Brazil (27º47' S latitude, 50º18' W longitude and 913 m a.s.l), on a 2 ha pasture of kikuyu grass (*Pennisetum clandestinum*) from November 2011 to May 2012. Climate of the experimental site is subtropical, without a defined dry season and with cool summers. Average air temperature varies between 9.2 to 10.8ºC in the coldest months and 19.4 to 22.3ºC in the warmest months. The experiment was conducted using a randomised complete block design, with three replications. Treatments corresponded to four targets of pre-grazing height (25 cm, corresponding to a canopy light interception of 95%; 20; 15 and 10 cm) which were associated with a single severity of grazing equivalent to removal of 50% of initial height, generating four post-grazing heights (12.5, 10.0, 7.5 and 5 cm, respectively). Sward height was measured twice a week in sixty points per experimental unit (paddock size around 1600 m^2). Measurements of herbage mass, forage morphology and chemical composition were made by harvesting two herbage samples using 25 x 25 cm metallic frames per experimental unit. At pre-grazing, herbage within the metallic frames were clipped from the top until the target post-grazing heights (top stratum) and then from that point to ground level (bottom stratum). Post-grazing, samples were harvested at ground level. Samples were hand dissected into leaves (lamina), stems (sheaths + stems), dead material and weeds. The material was dried in a convection oven at 65ºC for 48 hours then weighed to estimate dry mass (DM). Samples from the top stratum were ground and analysed for crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) concentration. Rate of herbage accumulation was determined by the difference between pre- and post-grazing herbage masses of successive grazing cycles divided by the number of days between grazings. Data were analysed using the *MIXED* procedure of the SAS® statistical package (SAS Institute, 1996) and grazing cycles were considered as repeated measurement. A t-test procedure was used to compare treatment means using a 5% significance level, and a non-linear regression was performed to assess the functional relationship between grazing height and total accumulated herbage throughout the experimental period.

Results and Discussion

Swards managed with the 10 cm pre-grazing height produced 67% of the total herbage accumulated on swards managed with the remaining pre-grazing heights throughout the experimental period, a direct result of the reduced rates of herbage accumulation under those circumstances (Fig. 1).

All pre-grazing targets showed a high proportion of leaves in the accumulated herbage (85-90%) (Fig. 2), and simply reflect the vertical distribution of morphological components in sward herbage mass, according to which approximately 90% of the stem component is located in the bottom stratum of swards regardless of plant species or targets of pre-grazing height (Zanini *et al.* 2012).

On the other hand, the 10 cm pre-grazing height resulted in a higher concentration of crude protein (CP) and a lower concentration of neutral (NDF) and acid (ADF)

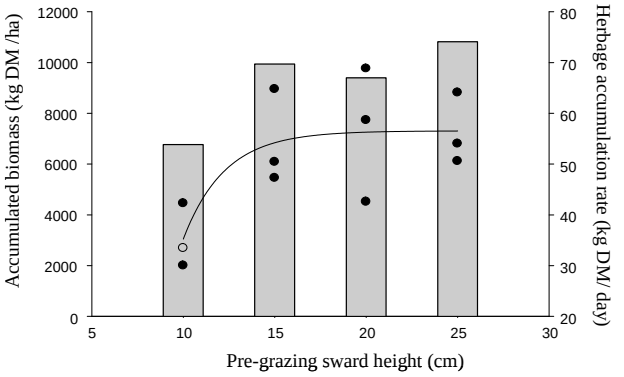

Figure 1. Herbage accumulation rate (solid circles) and total herbage accumulation (bars) in kikuyu grass subjected to strategies of rotational stocking management of similar severities of grazing. Pre-grazing sward height of 10cm significantly (P<0.05) lower than other heights.

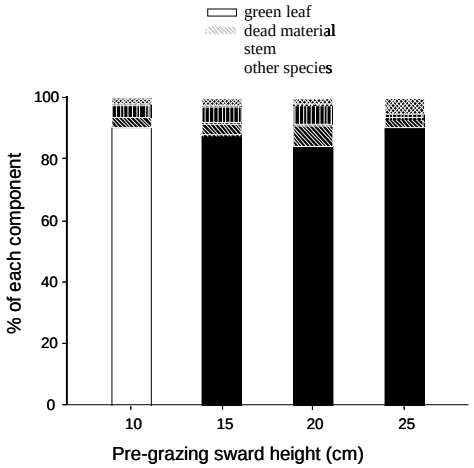

Figure 2. Proportion of leaf, dead material, stem and others species in kikuyu grass swards subjected to strategies of rotational stocking management of similar severities of grazing. Pre-grazing heights do not differ for green leaf proportion (P>0.05).

detergent fibre (Table 1). Such a result reflects the maturity of the leaves comprising the top stratum of the swards managed at 10 cm, since younger leaves have a higher concentration of non-structural carbohydrates, enzymes and lower concentration of structural components. There was no difference in CP, NDF and ADF between swards managed with the pre-grazing heights of 15, 20 and 25 cm. Such a pattern of result has been recently reported for *Brachiaria brizantha* cv. Marandu under continuous stocking (Da Silva *et al*. 2012). The authors also showed that the higher nutritive value of herbage produced on swards managed lower did not result in higher animal performance, since sward structure had a negative impact on herbage intake, characterised by a low bite mass and intake rate on these swards.

An ongoing experiment with *Panicum maximum* cv. Mombaça being carried out at the Brazilian Agricultural Research Centre - EMBRAPA/Beef Cattle - (Euclides, unpublished data) is revealing that it is possible to maintain similar and/or slightly higher animal performance using the pre-grazing target of 90% LI (live weight gain of 700 g) relative to the pre-grazing target of 95% LI (live weight gain of 675 g), since post-grazing height is not smaller than 50% of the pre-grazing height. Barbosa (2004), working with tanzania guinea grass noted that pastures managed

Table 1. Crude protein (CP), neutral (NDF) and acid (ADF) detergent fiber of kikuyu grass subjected to strategies of rotational stocking management of similar severities of grazing. SE represents standard error. Pre-grazing heights followed by the same letter do not differ (P<0.05).

	Pre-grazing sward height (cm)				SE	*P* value
	10	15	20	25		
CP	21.6 a	18.3 b	16.3 b	16.6 b	0.78	0.0071
NDF	60.0 b	62.7 a	63.9 a	64.1 a	0.63	0.0088
ADF	24.1 b	26.1 a	27.2 a	27.2 a	0.37	0.0019

with the pre-grazing target of 90% LI were characterised by herbage mass comprised of younger tillers and higher rates of tiller and tissue turnover than those managed with the pre-grazing targets of 95% and 100% LI, characteristics that could generate small differences in morphological and chemical composition of the consumed herbage. The similar production and morphological and chemical composition of herbage samples from swards managed with the pre-grazing targets of 15, 20 and 25 cm in this experiment suggest a strong similarity between grazing methods. Provided that defoliation is moderate, there is thus likely to be a range of pre-grazing sward heights within which herbage accumulation and nutritive value would be relatively stable. Using mathematical models, Parsons *et al.* (1988) demonstrated similarities between growth, senescence and net accumulation curves of pastures under continuous and intermittent grazing methods, and suggested that there would be no significant differences between methods for herbage production. Further, Wade *et al.* (1989), working with dairy cows under continuous or intermittent grazing over a wide range of sward surface heights, demonstrated that mean depth of defoliation corresponded to a relatively constant proportion (35%) of the mean extended tiller height, regardless of grazing and stage of the grazing down process. Wade (1991) also concluded that the relationship between frequency of defoliation of individual tillers and stocking density used could be considered the same for both grazing methods, continuous and intermittent stocking (Lemaire and Chapman, 1996). Such results provide the explanation why the literature does not allow conclusive findings on which grazing method allows higher animal performance or productivity (Briske *et al.* 2008).

Conclusions

The results presented here suggest that there is a range in targets of sward height pre-grazing for pastures managed under rotational stocking, provided defoliation used is moderate, not affecting the yield and chemical composition of the produced herbage. In this context, targets of sward height pre-grazing defined using the canopy light interception criterion would correspond to the maximum value of a range of possible sward heights to be used. Moreover, the choice of the pre-grazing target to be used in intermittent stocking, as for continuous method, would be a strategic decision according to which farmers would have to take into account factors like nutritional requirement of animals, animal category and stage of lactation among others.

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