Seasonal Patterns of Growth and Senescence in *Cynodon* spp. cv Tifton 85 Grazed Swards

L. F. M. Pinto
Universidade de São Paulo, Brazil

L. G. Barioni
Universidade de São Paulo, Brazil

S. C. da Silva
Universidade de São Paulo, Brazil

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SEASONAL PATTERNS OF GROWTH AND SENESCENCE IN *CYNODON* spp. cv TIFTON 85 GRAZED SWARDS

L.F.M. Pinto, L.G. Barioni, S.C. da Silva

Depto. Produção Animal - ESALQ/USP

Abstract

Growth and senescence are very important determinants of grassland productivity and correspond to key features to be considered for grazing management purposes. The present study was carried out at ESALQ, Piracicaba, S.P., Brazil and evaluated growth and senescence as a function of sward surface height. Mathematical models generated revealed that a similar pattern of response occurred as described in the literature for temperate grass species. However, a seasonal variation in response curves for growth and senescence was also observed and could be related to climatic events. Highest herbage accumulation rates were observed within the range of 15 to 20 cm of sward surface height.

Keywords: tiller, growth, senescence, model, regression, Tifton 85

Introduction

Herbage accumulation is the result of the net balance between growth and senescence (Bircham & Hodgson, 1983; Hodgson, 1990; Lemaire & Chapman, 1996). These are two concurrent and opposite processes, and agronomic practices may have different impacts on them (Korte & Sheath, 1979). This highlights the importance of understanding the functional relationship between herbage production and sward characteristics usually manipulated through grazing management strategies. There is an effective association between sward state variables, which define sward structure (i.e. leaf area index, herbage mass, sward surface height etc.), and the processes of growth and senescence (Hodgson, 1990). The present study aimed at evaluating the dynamic process of herbage accumulation through measurements of growth and senescence at individual tiller level. Mathematical models are presented in an attempt to describe the patterns of variation in growth and senescence in response to a range of sward surface heights.

Material and Methods

The experiment was carried out at Unidade Experimental de Plantas Forrageiras (UEPF), Departamento de Produção Animal, E.S.A. "Luiz de Queiroz", Universidade de São Paulo, Brazil. *Cynodon* spp. cv. Tifton 85 pastures were grazed by sheep under continuous stocking and variable stocking rate from May/1998. Grazing management was conducted in order to generate four steady state conditions characterised by sward surface heights (SSH) of 5, 10, 15 and 20 cm. Treatments were allocated to experimental units according to a complete randomised block design replicated four times. The experimental period started in Dec 12, 1998 and ended in July 17, 1999. During that period, measurements were made in 12-18/12/98, 02-08/02/99, 29/03/99-05/04/99 and 03-17/07/99.

Growth and senescence were evaluated at an individual tiller basis using the tissue flow technique described by Davies (1981). Treatment means were generated from 40 tillers in each measurement date. Herbage accumulation data was also generated from three exclosure cages (0,70 x 0,70 x 0,70 m) per experimental unit according to the method described by Frame (1981). Data from the tissue flow technique overestimated absolute values of herbage accumulation due to biased choice of marked tillers (Davies, 1981). On the other hand, data from the exclosure cage technique presented limitations in terms of relative differences in herbage accumulation due to overestimation and underestimation of dry matter production in short and tall swards, respectively (Frame, 1981). The data set used in the analysis of growth and senescence was balanced for limitations in both methods. This was achieved by combining the positive feature of the data set from tissue flow measurements (proportionality of readings for different SSH) and the positive feature from the cage technique (realistic absolute values).

Raw data for growth and senescence, collected from individual tillers, were transformed to values relative to the maximum herbage accumulation observed for the cages in each measurement date. This adjusted data set was used to choose and parameterise empirical mathematical models to describe the functional relationship between herbage accumulation traits and SSH. Senescence was modelled through simple linear regression using the least square method (Draper, 1981). Those linear models presented non significant lack of fit (Draper, 1981). Three non-linear models were chosen to characterize growth. Models tested were Wood ($G = b_0 SSH^{b_1} e^{-b_2 SSH}$; Wood, 1967) Mitcherlich ($G = b_0(1 - e^{b_1 SSH + b_2}$; Pimentel Gomes & Malavolta, 1949) and MitcherlichII ($G = b_0\left(1 - e^{b_1 SSH} e^{b_2 SSH^2}\right)$; Silva, 1980). The incomplete beta distribution model of Wood (1967) was found to be the most adequate and explained the highest proportion of the overall variation in the data set.

Results and Discussion

Patterns of growth for Tifton 85 swards were similar to those described for perennial ryegrass (Bircham & Hodgson, 1983; Hodgson, 1990, Lemaire & Chapman, 1996). Models did not present an asymptotic trend, and the highest values tended to be concentrated in the range of 15 to 20 cm SSH for February, April and July measurements. In December, however, the model suggested that the highest growth rate would have happened at a SSH above 20 cm (Figure 1). On the other hand, senescence presented no significant response to SSH in December and February (P > 0,1). This response may be related to a dry spell occurred in November/1998 that could have changed the competition factor, responsible for the balance within the plant community, from light to soil moisture. In that situation, sward conditions characterised by numerous population of small tillers would be more sensitive to dry conditions and would respond with higher tiller death and senescence rates (Carvalho, 2000). This could be augmented by the higher stocking densities observed on short swards (Carnevalli, 1999). During April and July senescence rates tended to behave similarly to the pattern described for perennial ryegrass in the literature, with high senescence rates in tall swards (Figure 2). In pastoral systems senescence proceeds with leaves that have completed their lifespan without being severed. For that reason senescence is modulated by both growth and grazing intensity, the latter determining the proportion that will not be lost to senescence and will determine pasture utilisation (Lemaire & Chapman, 1996). Therefore, plants under lenient grazing would be expected to have higher senescence rates than plants under hard grazing (Hodgson, 1990). As a consequence, during the experiment higher senescence rates occurred in taller swards, with exception for the December and February measurements.

Another typical feature of the data set is the seasonal pattern observed for both growth and senescence. Despite that, high growth rates tended to be associated with high senescence rates, with the highest values for growth and calculated herbage accumulation being observed between SSH of 15 and 20 cm. This is in accordance with data from Fagundes et al. (1999), which revealed that 95% of the incident light was intercepted at that range of SSH. As reported in the literature, 95% light interception correspond to situations where maximum average herbage accumulation rates are observed for perennial ryegrass swards (Parsons, 1988).

Grazing management should be adjusted to the seasonal variation of growth and senescence responses in the sward in order to maximise pasture production. Further studies should contemplate the effect of climatic conditions on sward response patterns and behaviour.

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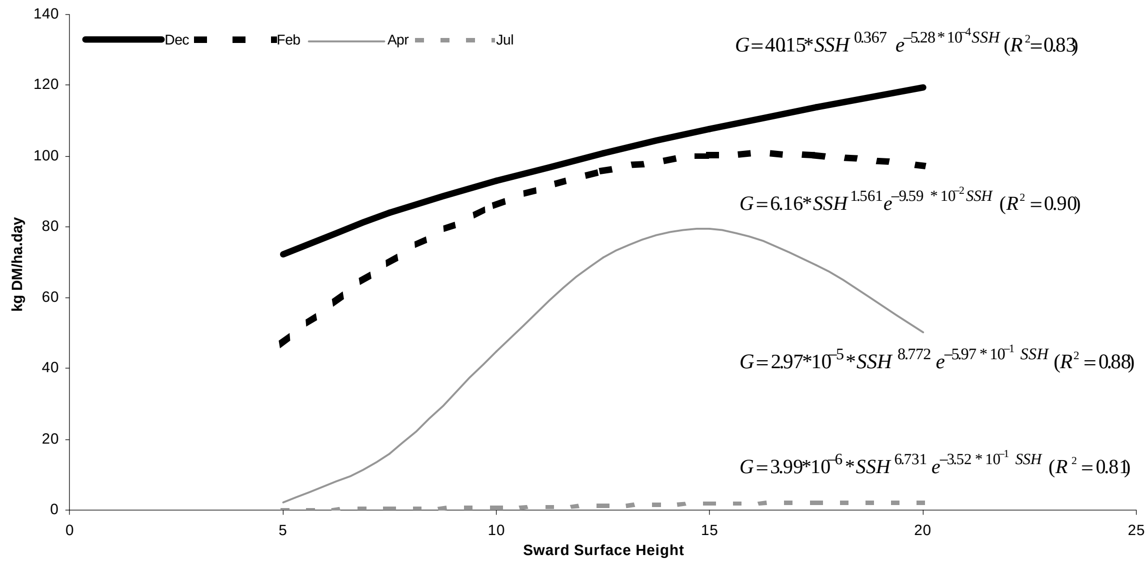

Figure 1 - Growth rates (kg DM/ha.day) for contrasting sward conditions as predicted by mathematical models throughout the experimental period.

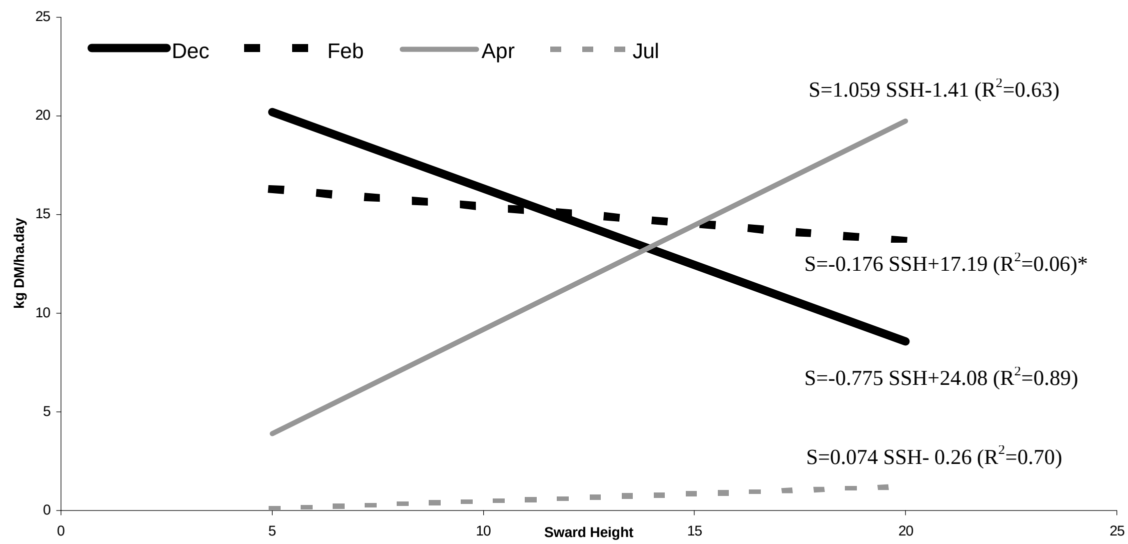

Figure 2 - Senescence rates (kg DM/ha.day) for contrasting sward conditions as predicted by mathematical models throughout the experimental period.