ID # 01-19

HERBAGE ALLOWANCE AND NITROGEN FERTILIZATION EFFECTS ON MORPHOLOGICAL CHARACTERISTICS OF *PASPALUM NOTATUM* FLÜGGE

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Abstract

The grazing study was conducted at the Estação Experimental Agronomica – UFRGS, 30^{o} S, on a native pasture, to evaluate the leaf area index and structural morphological traits of bahiagrass (*Paspalum notatum* Fl.), within the requirements of a Central Composite Rotatable experimental design, providing for equal precision, with two blocks, encompassing two factors at five levels each, namely: Herbage Allowance (HA) = 4.0; 5.5; 9.0; 12.5 and 14.0 kg green dry matter per 100 kg liveweight per day (% LW), in association with Nitrogen (N) fertilization levels of 0; 30; 100; 170 and 200 kg ha^{-1} as urea, The leaf length and leaf area index (LAI) were increased as HA and N levels increased. The tiller density was increased at higher HA where the N contribution showed to be more effective. More lenient grazing also increased leaf life span and leaf lamina length, while N promoted canopy density and reduced leaf life span and number of leaves per tiller. The higher LAI values developed were accomplished by reduced tiller densities that supported small number of leaves per tiller, with increased leaf sizes.

Keywords: bahiagrass, leaf area index, tiller density, leaf number, leaf size.

Introduction

Native pastures (NP) cover around 70 % of grazing lands of the South American subtropics, which gives support to the main feed source for the livestock industry (Moraes et al, 1995) down to the parallel 35^o S. Enough knowledge has been directed to develop understanding about the effects of grazing intensity on the botanical composition, seasonal dry matter yield and animal and pasture potential of these NP. *Paspalum notatum* Fl. ecotypes, namely bahiagrasses, predominate on the NP and contribute to most of this ecosystem diverted to feed the livestock industry. Increased forage dry matter yield responses to HA and N have been obtained, however very little is known about the interactions among these pasture management factors and their effects on modifying the morphological traits associated with plant structure (Chapman and Lemaire, 1993) that contribute to the development of leaf area index to intercept solar radiation, CO_2 sequestration to enhance pasture productivity. The study was conducted to evaluate important pasture morphological traits related to leaf area index (LAI) development of *P. notatum* Fl.

Material and Methods

The grazing study was conducted at the Estação Experimental Agronômica-UFRGS, Eldorado do Sul, RS, 30^o S, on a Plinthaquult soil type, limed and fertilized in 1978, and again in 1996, when 3 t ha^{-1} of dolomitic ground limestone and 500 kg ha^{-1} of a compound N, P_2O_5, K_2O fertilizer (05:20:20) was broadcast on top of the NP. The research was conducted fullfilling the requirements of a Central Composite Rotatable experimental design (Cochram and Cox, 1957), providing for equal precision, with two blocks, encompassing two factors at five levels each, namely: Herbage Allowance (HA) levels of 4.0; 5.5; 9.0, 12.5 and 14.0 kg green dry matter per

100 kg liveweight per day (%LW) and Nitrogen (N) levels of 0; 30, 100; 170 and 200 kg N ha^{-1}, split in two applications as urea. The paddocks were intermittently grazed within a grazing cycle of 38 days allowing for three days of grazing. Leaf area index estimates (LAI) were taken at weekly intervals along the grazing cycles of January and March 1998. From each pasture a sample area of 0.5 m^2 was cut at ground level and the live green leaf lamina of *P. notatum* Fl. were hand separated and weighed. Leaf lamina subsamples were taken to a leaf area meter (LICOR, LI-3100) for leaf area determinations, after which subsamples were ovendried until constant weight for leaf lamina specific weight determinations. The total leaf lamina dry weight was divided by the specific leaf lamina weight resulting in the LAIs for the experimental pasture treatments. The dynamics of leaf development of *P. notatum* Fl. were evaluated concomitantly, according to Hodgson (1966) and Mazzanti & Lemaire (1994) to study individual tillers in grazed pastures.

Results and Discussion

The LAI developed after 33 days of regrowth adjusted to the response surface model: $= 5.72 - 0.73HA - 0.01N + 0.03HA^2 + 3.20\times10^{-3}HA*N - 4.3\times10^{-6}N^2 + 0.60B$ ($R^2 = 0.895$), with a significant quadratic response to HA and to the HA*N interaction, showing higher LAI values (up to 9.4) at high HA and N levels. At low HA levels, the LAI responded differently than at high HA for the N levels (Figure 1A). The number of expanded leaves per tiller of *P. notatum* Fl. (Figure 1 B) adjusted to the response surface model: $= 3.74 + 0.16HA - 4.70N - 9.8\times10^{-3}HA^2 + 1.50\times10^{-4}HA*N - 3.80\times10^{-6}N^2 + 6.70\times10^{-2}B$ ($R^2 = 0.785$), increasing linearly as the N levels were reduced. According to the model the number of expanded leaves varied from 3.3 (HA = 4.0 % LW and 200 kg N ha^{-1}) to 4.4 expanded leaves attained at HA = 9.0 % LW and 0 kg N ha^{-1}. Under NP conditions Eggers (1999) observed 4 expanded leaves of *P. notatum* Fl. for the range of 4.0 % up to 12.0 % LW based on total above-ground dry matter. The number of expanded leaves comes from the interactions among determinants of the time for leaf appearance (TLA) and leaf life length (LLL). The TLA was extended as HA increased, with a concomitant reduction in N levels, adjusting to the response surface model of $= 5.62 – 3.62x10^{-2}HA + 8.20x10^{-3}N + 9.40x10^{-3}HA^2 – 5.10x10^{-5}HA*N – 2.30x10^{-5}N^2 +1.35B$ ($R^2 = 0.738$). This results in a longer fully expanded leaf which determines an increased time interval for two consecutive leaves (TLA). However, an increase in TLA does not mean changes in the phylocron. The increased phylocron is a consequence of changes in the structure of the tiller that develops longer sheaths and the new leaf has to travel a little bit more inside the whorl, inasmuch this does not mean changes in the plastochron either. The leaf length (Figure 1 C) adjusted to the response surface model $= 3.09+ 0.12HA + 3.40x10^{-3}N + 1.33x10^{-2}HA^2 – 7.55x10^{-4}HA*N – 4.74x10^{-5}N^2 + 0.22B$ ($R^2 = 0.764$), with a sharp response to N and to HA. From the high correlation among leaf lamina extension rate per tiller (r = 0.963) came the idea that tillers bearing longer leaves are those exhibiting higher leaf extension rates per tiller. The correlation between lamina length and green lamina length per tiller (LLT) (r = 0.99) indicates that tillers bearing longer green lamina exhibit longer lamina lengths. From this stands that tillers exposing greater leaf area carry longer leaves instead of a larger number of smaller leaves. The TLA showed to be dependent on HA, as a response to the effect of HA upon the sheath length, thus reducing TLA while increasing leaf life span (LLS). From the relationships of these sward structural variables with N, one can see that by reducing N levels there is an increase in the number of leaves per tiller with a reduced leaf length but with a longer LLS. By increasing N levels there are reduced number of longer leaves per tiller, with shorter LLS, what can compensate for higher leaf extension rate. Tiller density is a consequence of the leaf appearance rate, and increases with the reduction in HA, adjusting to the response surface model $= 6465.19 – 632.55HA + 6.66N + 30.19HA^2 –0.72HA*N + 0.02N^2 –255.22B$

(R^2 = 0.90) with N contributing at higher levels of HA (Figure 1 D). By reducing HA there is an increase in grazing intensity, which stimulates the rate of defoliation and generates more sites for leaf and tiller development in *P. notatum* Fl. up to 5719 tillers m^{-2} for HA = 4.0 % LW and 200 kg N ha^{-1}. However, Eggers (1999) did not observe a clear reaction of *P. notatum* Fl to HA under NP conditions without N application. The conclusions that can be drawn are that LAI is increases as HA and N are increased and the larger leaf area developed was a multiple product of the reduced tiller densities bearing smaller number of leaves which were of longer sizes.

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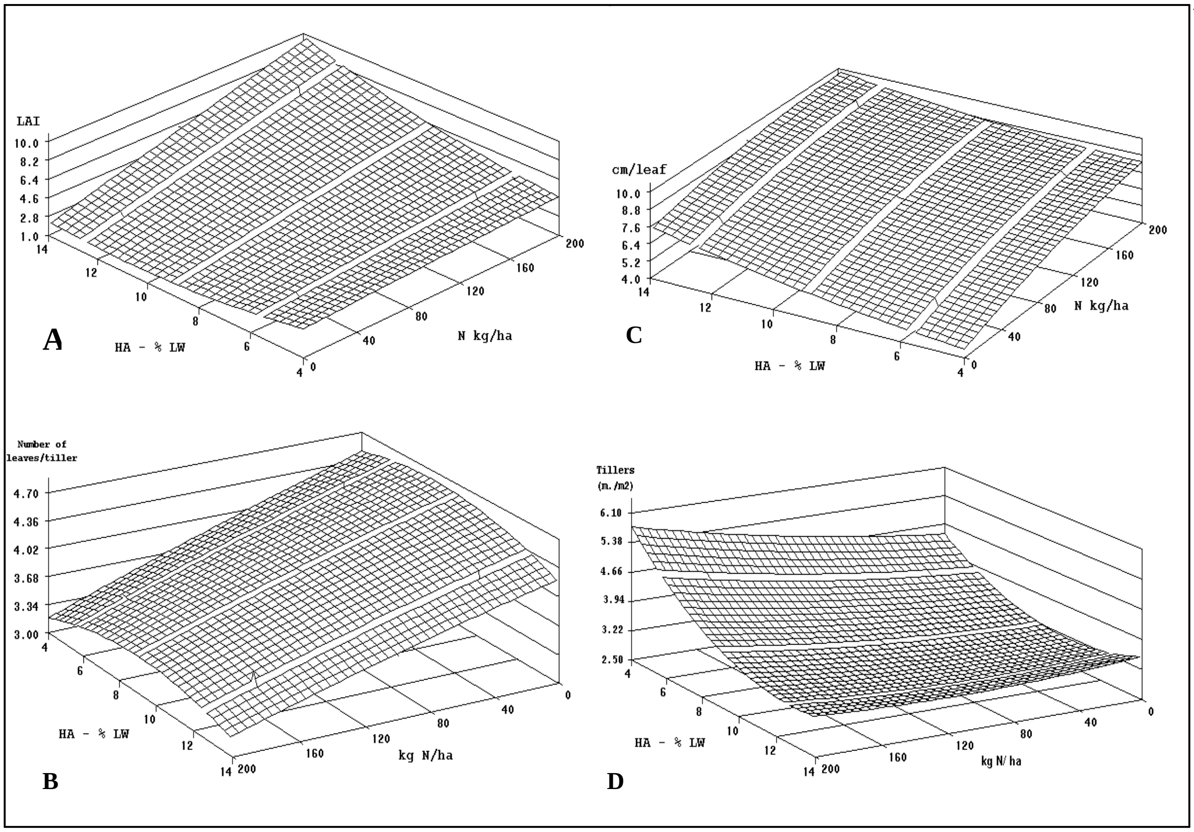

Figure 1 - Relationship between A) Leaf Area Index of P.notatum Fl., B)- Number of leaves per tiller, C)- Length of leaf lamina and D)- Tiller density, and levels of Herbage Allowance and Nitrogen.