Tropical Grasslands – Forrajes Tropicales (2014) Volume 2, 12−14

Phyllochron and leaf lifespan of four C4 forage grasses cultivated in association with trees

TIAGO C. BALDISSERA[1,2], LAÍSE DA S. PONTES[2], RAQUEL S. BARRO[3], ANDRÉ F. GIOSTRI[1,2], KELI C.S. GUERA[1], MIQUÉIAS MICHETTI[1], VANDERLEI P. DA SILVA[4] AND PAULO C. DE F. CARVALHO[3]

[1]*Universidade Federal do Paraná, Curitiba, PR, Brazil.* www.ufpr.br
[2]*Instituto Agronômico do Paraná, Londrina, PR, Brazil.* www.iapar.br
[3]*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil.* www.ufrgs.br
[4]*Empresa Brasileira de Pesquisa Agropecuária, Embrapa Florestas, Colombo, PR, Brazil.* www.cnpf.embrapa.br

Keywords: Morphogenesis, light interception, nitrogen, cutting frequency.

Introduction

Silvopastoral systems are emerging as an option for more sustainable land use. However, the challenge is to optimize pasture production and determine suitable management by understanding the growth and development of forages under tree canopies (Palma et al. 2007). In silvopastoral systems, trees change the environment under which forages grow, and can influence the development of plants and, consequently, sward dynamics. For instance, both light quantity (i.e. photon flux density) and quality (e.g. changes in red:far-red ratio) can be influenced by the tree canopy (Beaudet et al. 2011).

Phyllochron and leaf lifespan are morphogenic processes that control growth and development of plants by determining leaf area index and thus light interception by the sward (Lemaire and Chapman 1996). Both characteristics can be used as tools for pasture management and are influenced by management practices, like nitrogen fertilization. However, few studies have examined these characteristics for forages under a tree canopy (Paciullo et al. 2008), particularly when using light interception (LI) as a criterion for cutting frequency. Under full sun, rotational stocking using 95% canopy LI has been recommended for using C4 species to their fullest potential and to optimize ruminant weight gains on pastures (da Silva and Carvalho 2005).

The aim of our work was to determine the effects of shading (5-year-old plantation of *Eucalyptus dunnii*) and nitrogen availability on phyllochron and leaf lifespan of four C4 forage grasses in a subtropical environment, using the 95% light interception criterion to determine cutting frequency.

Correspondence: Tiago C. Baldissera, Universidade Federal do Paraná (UFPR), Rua dos Funcionários, 1540, Juvevê, Curitiba CEP 81.531-990, PR, Brazil.
Email: tiagobaldissera@agronomo.eng.br

Materials and Methods

The study was located at the Agronomic Institute of Paraná, Ponta Grossa, PR (25°07'22'' S, 50°03'01'' W). It examined 4 perennial C4 grasses (*Cynodon* hybrid Tifton 85, *Hemarthria altissima* cv. Florida, *Megathyrsus maximus* (syn. *Panicum maximum*) cv. Aruana and *Urochloa* (syn. *Brachiaria*) *brizantha* cv. Marandu) that are widely used in Brazilian cattle production, and are also recommended for use in silvopastoral systems (e.g. Soares et al. 2009).

The trees (*Eucalyptus dunnii*) were planted in 2007 in a double-row arrangement using 3 m between plants within rows and 4 m between rows, spaced 20 m apart (3 x 4 x 20 m) giving 155 trees/ha. The grasses were planted in pure stands in 2010 (4.5 m² in unshaded and 100 m² in the shaded area). Treatments were arranged in a split-split plot design, with 3 replicates. Shaded (i.e. system with trees) and unshaded conditions were the main plots, grass species were the subplots and 2 contrasting N levels (zero and 300 kg N/ha/yr; N0 and N300) were assigned to sub-subplots. The photon flux density was reduced on average by 34 ± 8.6% in the shaded area compared with the unshaded area. Forages were cut when light interception by the swards reached 95%. Rotational defoliation was simulated by mechanical cutting. Temperature was measured every 5 minutes during the experimental period (December 2011); in the shaded area, 3 thermometers, placed between the lines of trees, were used. Thermal time was calculated from the daily integration of air temperatures minus the base temperature (i.e. 10 ºC). To assess phyllochron and leaf lifespan, 4 measurements were done in 25 and 10 tillers per plot for shaded and unshaded areas, respectively, every 3-5 days, during 20 days in December 2011. The rate of leaf appearance was calculated by the linear regression between thermal-time (ºCd) and the number of visible leaves. Then phyllochron was calculated as the reciprocal of the rate of leaf appearance. The number of green mature leaves (GML) per tiller was recorded and the leaf life span was calculated by multiplying the number of GML per tiller by the phyllochron. Statistical analyses were performed using R software (www.r-project.org). The data were subjected to Analysis of Variance (ANOVA) and Tukey test for comparison of means.

Results and Discussion

Phyllochron for species growing under unshaded conditions (94.3 ± 36.23 ºCd) was lower than for species under trees (114.7 ± 33.87 ºCd). Therefore, shade reduced the rate of plant development, in contrast with the findings of Paciullo et al. (2008), who did not observe phyllochron changes in *Brachiaria decumbens* under *Eucalyptus grandis* canopy at 50% shade. Nitrogen fertilization reduced the phyllochron (114.9 ± 39.93 for N0 vs. 94.0 ± 29.22 for N300). Nitrogen is well known in the literature to accelerate plant growth and development (Paiva et al. 2012).

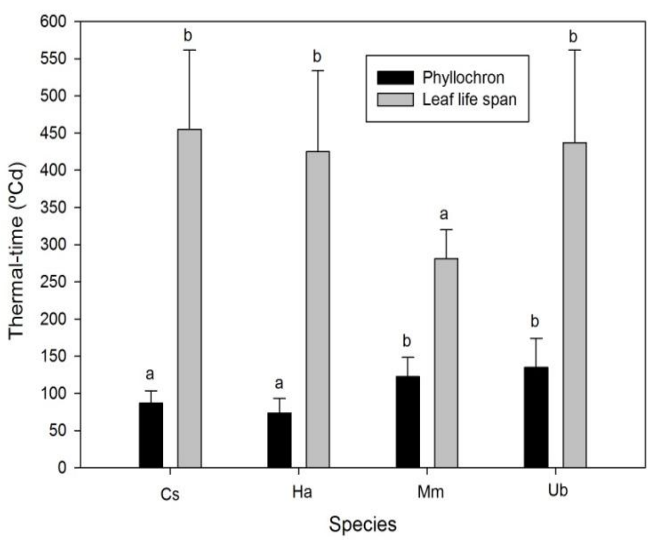

Figure 1. Phyllochron and leaf life span of four C4 grasses [*Cynodon* hybrid Tifton 85 (Cs), *Hemarthria altissima* cv. Florida (Ha), *Megathyrsus maximus* (syn. *Panicum maximum*) cv. Aruana (Mm) and *Urochloa* (syn. *Brachiaria*) *brizantha* cv. Marandu (Ub)]. Different letters indicate significant differences between species for phyllochron and leaf life span (P<0.05). Bars indicate the standard deviation.

Phyllochron differences between species were significant (Figure 1). Species with lower phyllochron, i.e. higher growth rate, showed higher numbers of green mature leaves (P<0.0001). However, no significant treatment x species interactions for phyllochron were observed (P>0.056).

Leaf lifespan for *M. maximus* (syn. *Panicum maximum*) cv. Aruana was shorter than for those of the other species (Figure 1). The mean daily temperature during the experimental period was 21 ºC, ranging from 12 to 32 ºC. On average, the leaf lifespan of all species was 352 ºCd. From this value and the mean daily temperature minus base temperature, an advisable cutting frequency of around 32 (days) was calculated for both unshaded and shaded conditions. Despite the same leaf lifespan and, consequently, a similar cutting frequency, the lower rate of development for species growing under shade could, however, affect the time for a sward to reach 95% light interception, commonly recommended as the indicator for a cutting or grazing decision.

Conclusions

Grass plants growing under tree canopy have a higher phyllochron than plants growing under full light, but this can be counteracted by application of N fertilizer. Differences in leaf lifespan between species would result in different optimal cutting frequencies, and this would be the same regardless of shading or N levels.

Acknowledgments

This work was supported by the Cooperation Agreement (N° 21500.10/0008-2) between IAPAR and Embrapa, and financially also by CNPq (Repensa).

References

Beaudet M; Harvey BD; Messier C; Coates KD; Poulin J; Kneeshaw DD; Brais S; Bergeron Y. 2011. Managing understory light conditions in boreal mixedwoods through variation in the intensity and spatial pattern of harvest: A modelling approach. Forest Ecology and Management 261:84–94.

da Silva SC; Carvalho PCF. 2005. Foraging behaviour and herbage intake in the favourable tropics/sub-tropics. In: McGilloway DA, ed. Grassland: A global resource. Proceedings of the XX International Grassland Congress, Dublin, Ireland, 2005. p. 81−95.

Lemaire G; Chapman D. 1996. Tissue flows in grazed plant communities. In: Hodgson J; Illius AW, eds. The ecology and management of grazing systems. CAB International, Wallingford, UK. p. 3−36.

Paciullo SD; Campos NR; Augusto C; Gomide M. 2008. Crescimento de capim-braquiária influenciado pelo grau de sombreamento e pela estação do ano. Pesquisa Agropecuária Brasileira 47:917–923.

Paiva AJ; Carneiro S; Elgalise L; Pereira T; Guarda DA; Pereira PDM; Caminha FO. 2012. Structural characteristics of tiller age categories of continuously stocked marandu palisade grass swards fertilized with nitrogen. Revista Brasileira de Zootecnia 41:24−29.

Palma JHN; Graves AR; Bunce RGH; Burgess PJ; de Filippi R; Keesman KJ; van Keulen H; Liagre F; Mayus M; Moreno G; Reisner Y; Herzog F. 2007. Modeling environmental benefits of silvoarable agroforestry in Europe. Agriculture, Ecosystems and Environment 119:320−334.

Soares AB; Sartor LR; Adami PF; Varella AC; Mezzalira JC. 2009. Influence of luminosity on the behavior of eleven perennial summer forage species. Brazilian Journal of Animal Science 38:443−451.

Baldissera TC; Pontes LS; Barro RS; Giostri AF; Guera KCS; Michetti M; Silva VP da; Carvalho PCF. 2014. Phyllochron and leaf lifespan of four C4 forage grasses cultivated in association with trees. Tropical Grasslands – Forrajes Tropicales 2:12–14.
DOI: 10.17138/TGFT(2)12-14

This paper was presented at the 22nd International Grassland Congress, Sydney, Australia, 15−19 September 2013. Its publication in *Tropical Grasslands – Forrajes Tropicales* is the result of a co-publication agreement with the IGC Continuing Committee. Except for adjustments to the journal's style and format, the text is essentially the same as that published in: **Michalk LD; Millar GD; Badgery WB; Broadfoot KM, eds. 2013. Revitalising Grasslands to Sustain our Communities. Proceedings of the 22nd International Grassland Congress, Sydney, Australia, 2013. New South Wales Department of Primary Industries, Orange, NSW, Australia. p. 1029–1030.**