Dynamic of dominance, growth and bromatology of *Eragrostis plana* Nees in secondary vegetation area[1]

Dinâmica da dominância, crescimento e bromatologia de *Eragrostis plana* Nees em área de vegetação secundária

Simone Meredith Scheffer-Basso[2]*, Kalinca Cecchin[2] and Adriana Favaretto[2]

ABSTRACT - The objective of this work was to evaluate the dominance, growth and bromatology of tough lovegrass or 'annoni' grass (*Eragrostis plana*) in secondary vegetation area. The evaluations were carried out at 23, 45, 64, 86, 111, 132, 153, and 174 days of growth after a mowing. The tough lovegrass was the dominant species on the area, accounting for 76 to 90% of biomass. There was a linear increase for leaf (9.8 kg DM ha^{-1} day^{-1}) and total dry mass (16.9 kg DM ha^{-1} day^{-1}) of the tough lovegrass. During the 111 days of the vegetative stage, the biomass was composed only of leaves, and the flowering started at 132 days. At 174 days, the tough lovegrass accumulated about 4,000 kg DM ha^{-1}, 650 kg DM ha^{-1} of which was composed of inflorescences. The growth analysis revealed a specific leaf area of 72 cm^2 g^{-1} and a maximum leaf area index of 2.1. The leaf area ratio decreased from 72.2 to 43.9 cm² g^{-1} between the 23rd and 174th days. The bromatological analysis showed a high content of neutral detergent fiber (85.3-90.4%) and acid detergent fiber (39.4-42.8%), as well as low crude protein content (3.9-9.9%), indicating the low forage quality of the species.

Key words: Crude Protein. Dry matter. Fiber. Leaf area index. Leaf area ratio.

RESUMO - O objetivo deste trabalho foi avaliar a dominância, crescimento e bromatologia do capim-annoni (*Eragrostis plana*) em área de vegetação secundária. As avaliações foram realizadas aos 23; 45; 64; 86; 111; 132; 153 e 174 dias de crescimento após uma roçada. O capim-annoni foi a espécie dominante na área, representando entre 76 e 90% do total da biomassa. Houve aumento linear na produção de massa seca de folhas (9,8 kg MS ha^{-1} dia^{-1}) e da parte aérea (16,9 kg MS ha^{-1} dia^{-1}) do capim-annoni. Durante os 111 dias da fase vegetativa, a biomassa das plantas foi composta somente por folhas. O florescimento iniciou a partir do 132° dia após o corte. Aos 174 dias de crescimento, o capim-annoni acumulou cerca de 4.000 kg de MS ha^{-1}, dos quais 650 kg MS ha^{-1} foi composta por inflorescências. A gramínea apresentou área foliar específica de 72 cm² g^{-1} e índice de área foliar máximo de 2,1. A razão de área foliar reduziu de 72,2 para 43,9 cm² g^{-1} entre o 23° e o 174° dia após o corte. A análise bromatológica mostrou elevados teores de fibra em detergente neutro (85,3-90,4%) e fibra em detergente ácido (39,4-42,8%), e baixo teor de proteína bruta (3,9-9,9%), indicando a baixa qualidade nutricional do capim-annoni.

Palavras-chave: Fibra. Índice de área foliar. Massa seca. Proteína bruta. Razão de área foliar.

INTRODUCTION

African C_4 grasses have spread widely at an alarming rate. The earliest record of the invasive alien plant species in Brazil is of African grasses in pastures near Rio de Janeiro (South-Eastern Brazil) from the early 18th century (ZENI; ZILLER, 2011). The physiognomic-ecological class of the tough lovegrass is steppe, tropical, and subtropical ombrophilous forest and salt meadow, which represents several ecoregions of Brazil, including Cerrado, Uruguayan savanna, Alto Paraná Atlantic forests, Bahia coastal forests, Araucaria moist forest, and Bahia interior forests (ZENI; ZILLER, 2011), as well as in Argentina and Uruguay (BOGGIANO *et al.*, 2004).

Identifying the factors that influence invasion by exotic plant species is of critical importance because many traits may contribute to determine their success (SMITH; KNAPP, 2001). Plant traits - the morphological, anatomical, physiological, biochemical and phenological characteristics of plants and their organs - determine how primary producers respond to environmental factors, affect other trophic levels, influence ecosystem processes and services and provide a link from species richness to ecosystem functional diversity (KATTGE *et al.*, 2011). As plants grow, there is a reduction in the density and in the proportion of leaves and an increase in the stem proportion, meaning there is an increase in the proportion of structural components (cell walls), discouraging intake (MACEDO JÚNIOR *et al.*, 2007). Plant species that are selectively less consumed and have a competitive advantage relative to palatable ones, increasing their persistence in grasslands. Therefore, the identification of attributes of nutritional value and dynamic growth components can assist in the understanding of invasion potential and biotic control of the species.

This study had the objective to characterize the tough lovegrass as for the dynamic of dominance, growth and bromatology, in order to identifying possible traits that influence the persistence of the species in natural grasslands and ruderal areas.

MATERIAL AND METHODS

The study was carried out in Passo Fundo (28° 15´S, 52° 24´W), Rio Grande do Sul, Brazil, between September 2010 and February 2011. The climate is subtropical subtype Cfa. The information on temperature and rainfall recorded during the experimental period is shown in Figure 1. The soil is Oxisol, and presented the following characteristics: clay content: 40.7%; pH in water: 5.3; P: 6.6 mg dm^{-3}; K: 164 mg dm^{-3}; organic matter: 3.7%; Al: 0.3 $cmol_c$ dm^{-3}; Ca: 4.2 $cmol_c$ dm^{-3}; Mg: 1.9 $cmol_c$ dm^{-3}; CEC: 15.2 cmolc dm^{-3}; base saturation: 43%; Al saturation: 4%; K saturation: 2.8%. S: 10.0 mg dm^{-3}; Mn: 30.9 mg dm^{-3}; Bo: 0.5 mg dm^{-3}; Zn: 1.20 mg dm^{-3}; and Cu: 2.1 mg dm^{-3}. The experimental site is an area of secondary vegetation with perennial grasses, small dicots in the lower stratus, and tough lovegrass in the upper stratus. The site is not subject to fertilization or burning, and the most common disorders are systematic mowing and some traffic of agricultural machinery. In August 2010, an experimental area of 70 m^2 was marked, fenced, and mowed. The plant material was removed from the surface with the aid of rakes. No fertilizers were applied during the experimental period.

Figure 1 - Monthly rainfall (R), Mean daily temperature (MDT), mean daily minimum temperature (MDMinT) and mean daily maximum temperature (MDMaxT), during the experimental period
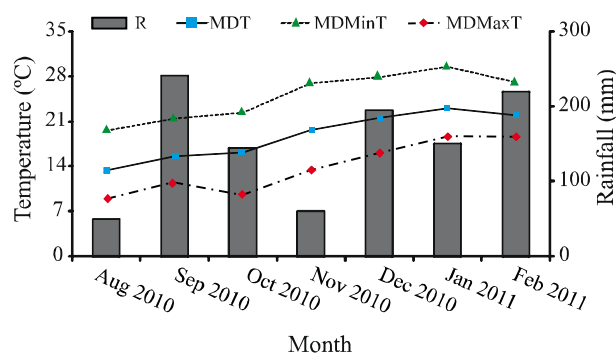
The evaluations were performed at 23 (9/16/2010), 45 (10/8/2010), 64 (10/28/2010), 86 (11/17/2010), 111 (12/9/2010), 132 (1/3/2011), 153 (1/24/2011) and 174 (2/14/2011) days of growth after mowing (DAM) in 10 sampling units (replications) of 0.12 m^2 (0.40 m x 0.30 m), marked by metal frames spread over the vegetation, totaling 80 samples in the experimental period. These procedures are commonly used in assessments of grassland communities (BARUCH; HERNÁNDEZ; MONTILLA, 1989; SILVA; HARIDASAN, 2007). The canopy height was measured and all above-ground standing biomass (dead + live) within randomly selected sampling units on each harvest date was collected by clipping at the ground level. Above-ground live biomass (AGLB) was separated into the following components: leaf, culm, and inflorescence of tough lovegrass, other monocots, and dicots. The leaf area (LA) of tough lovegrass was estimated using an electronic planimeter and its value was multiplied by 2 because the leaf blades fold lengthwise along the midrib.

Then, the AGLB components were oven-dried to constant mass at 60 °C and weighed. Based on the LA and leaf dry mass (LDM), the specific leaf area (SLA) was calculated (LA/LDM). This procedure was performed in the first two harvests and the LA for the other samples was obtained from the mean SLA of the 20 samples (LA= SLA x LDM). The leaf area index (LAI) and leaf area ratio (LAR) were calculated.

The leaf samples were analyzed as for the crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) content using near-infrared spectroscopy (NIRS) method. The NIRS calibration and validation was conducted by Centro de Pesquisas em Alimentação (CEPA), of Universidade de Passo Fundo (Table 1). The samples were analyzed using the reference methods to determine CP, NDF and ADF, and they were also analyzed by spectroscopy (NIRS), using a wave length region from 1100 to 2500 nm. Data was mathematically treated by the Match program and then a regression model was fitted, having the results from the chemical analysis as independent variables and the results from the near infrared reflectance as dependent variables. The evaluation of the adjustment level was made through the determination coefficients (R^2) (FONTANELI *et al.*, 2004). The accuracy (R^2) was elevated for CP, NDF and ADF, indicating the validity of this method to predict such parameters in grasses.

The data were submitted to a variance analysis at 5% error probability, taking into account the DAM, using the split plot on time (eight evaluation dates) design and ten replications (ten sampling units/evaluation date). When significant, the quantitative factor was tested in polynomial regressions considering the greater significant level.

RESULTS AND DISCUSSION

The climatic conditions that occurred during the experimental period were adequate for the growth of tough lovegrass, except for the months of August and November, when the rains were below normal (Figure 1).

The tough lovegrass was the dominant species on the area, accounting for 76 to 90% of total standing live biomass (Figure 2), thereby demonstrating its high competitiveness against other species. Dicots decreased their contribution during the growth season, from 13% to 2%. This group of plants was represented by the following families and species: Asteraceae (*Baccharis trimera* (Less.) DC, *Soliva pterosperma* (Juss.) Less.), Malvaceae (*Sida rhombifolia* L.), Plantaginaceae (*Plantago tomentosa* Lam.), Campanulaceae (*Wahlenbergia linarioides* (Lam.) A. DC), and Fabaceae (*Trifolium riograndense* Burkart; *T. repens* L.). The contribution of the other monocots decreased from 10% to 7% between the onset and end of the assessments, and this was represented mainly by grasses (*Axonopus* spp., *Calamagrostis* sp., *Chloris* sp., *Lolium multiflorum* Lam., *Paspalum* spp.) and some cyperaceous plants.

Figure 2 - Relative contribution of tough lovegrass to the above-ground live standing biomass in the area
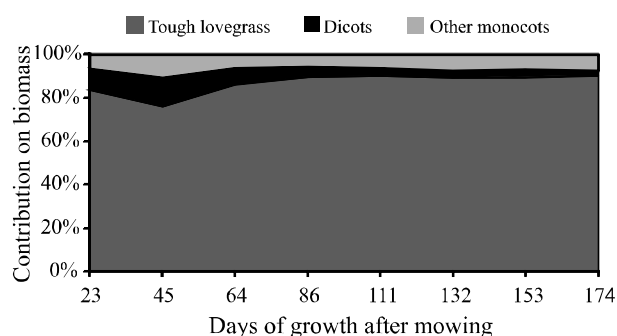
The conditions of soil fertility in the experimental area were not suitable for the growth of more demanding species present at the site (*Trifolium* spp., *Paspalum* spp.), which contributed to the greater dominance of the grass. Foy *et al.* (1979) observed that tough lovegrass was more tolerant to acid mine spoil (pH 3.5), but less tolerant to calcareous soil (pH 7.3) than *Eragrostis*

Table 1 - Statistics of the NIRS calibration and validation for crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of forage obtained for forage grasses in Centro de Pesquisas em Alimentação, Universidade de Passo Fundo

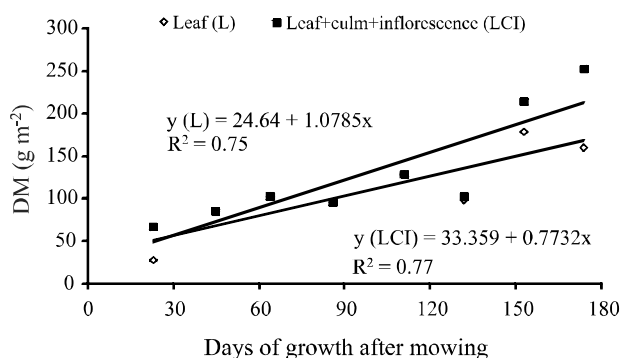| Constituent	Samples	Mean	SEC	R2	SECV	r
CP	439	9.84	0.73	0.9764	0.74	0.9764
NDF	262	64.00	1.53	0.9574	1.60	0.9574
ADF	377	34.72	1.50	0.9479	1.53	0.9479

SEC: standard error of calibration; SECV: standard error of cross-validation; R^2 = Coefficient of multiple correlation; r = Validation correlation coefficient

superba Peyr which suggested that superior strains of *Eragrostis* species can be selected for adaptation to calcareous or acid soils. Moreover, it implied that certain accessions characterized in these studies can be useful in studying the physiological mechanisms of mineral stress resistance in plants.

The quick invasion of tough lovegrass has been widely reported in areas degraded by inadequate agricultural practices, burning, and high grazing pressure, which leave soil surfaces uncovered, and has been associated with the colonization of poor, compacted soils (BOGGIANO *et al.,* 2004). These conditions are often observed at marginal cropping areas, as there is extensive traffic from tractors, big wagons, and vehicles, which restricts germination and seedling development and reduces floristic diversity. Thus, opportunistic and aggressive species that tolerate these conditions, such as tough lovegrass, become progressively dominant. This grass, once established, extracts more resources from the environment (nutrients, light, water, etc.) than do native plants, as it has a larger root mass, developing and producing sizeable amounts of seeds at each growth stage, which allows its frequency and coverage to increase every year (MEDEIROS; FOCHT, 2007). Therefore, the final outcome is the replacement of native species with a nearly exclusive tough lovegrass community, leading to the loss of plant biodiversity (BOGGIANO *et al.*, 2004).

Leaf dry mass and total dry mass of tough lovegrass (TTG= leaf+culm+inflorescence) showed a linear increase, with about 4,000 kg DM ha^{-1} of TTG at 174 DAM (Figure 3). This value was similar to obtained in South Africa (FYNN; O'CONNOR, 2005) and Uruguay (RIOS, 2007) for the species.
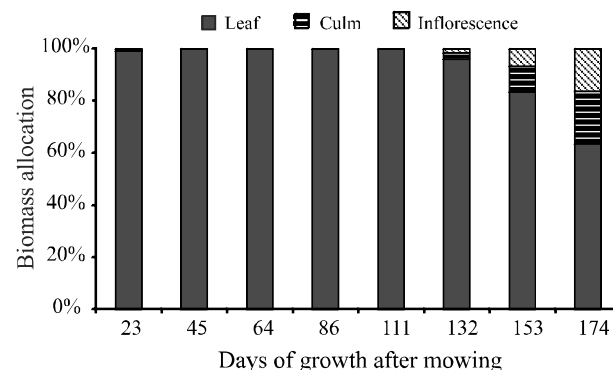
The LDM and TTG increased at rates equivalent to 9.8 and 17 kg DM ha^{-1} day^{-1}, respectively, which were inferior to what is commonly recorded for breeding tropical grasses. In fertilized sites, values recorded for *Brachiaria* spp. indicated a range of 20 kg LDM ha^{-1} day^{-1} (FAGUNDES *et al.*, 2005)). These results suggest that the introduction of fast-growing tropical species in areas dominated by tough lovegrass is a control alternative to be tested. In addition to competing for soil resources, the introduction of fast-growing species would provide shading, which is not tolerated by tough lovegrass. Medeiros and Ferreira (2011) observed that grasses occurring in roadside vegetation, such as *Paspalum plicatulum* Michx. and *Piptochaetium montevidense* (Spreng.) Parodi, as well as an introduced native species, *Paspalum urvillei* Steud, can potentially control tough lovegrass in this habitat.

The partitioning patterns of plants are one of the most important in ecological terms because the process has a direct effect on a plant's ability for seed production (HEGAZY, 1990). In this study, an expressive DM allocation to leaf was observed during the vegetative stage (Figure 4).

Figure 4 - Biomass allocation (in accumulated percentage) of tough lovegrass to leaf, culm, and inflorescence during the experimental period

Figure 3 - Leaf and total (leaf+culm+inflorescence) dry mass of tough lovegrass as a function of days after mowing. [For transformation to kg ha^{-1}, multiply by 10.]

$$y (L) = 24.64 + 1.0785x$$
$$R^2 = 0.75$$

$$y (LCI) = 33.359 + 0.7732x$$
$$R^2 = 0.77$$

The maintenance of leaves in the canopy for a long period favors competitiveness against other species, since this is the major photosynthetic organ. The success of African grasses, such as molasses grass (*Melinis minutiflora* P. Beauv.) in Venezuelan savannas, is partly due to the larger allocation of photoassimilates to leaves compared to native species (BARUCH; HERNÁNDEZ; MONTILLA, 1989). In Venezuela, the invasion by molasses grass is similar to what has occurred with tough lovegrass in southern Brazil, and

its dense growth excludes other species, resulting in associations that are basically monospecific. The period of the vegetative growth of the tough lovegrass was about four months, and flowering occurred from early summer. However, at 174 DAM, the inflorescences accounted for about 20% of the plant biomass - about 650 kg DM ha^{-1}. This grass can produce about 500,000 seeds, with viability greater than 90% (RIOS, 2007), strengthening the importance of early mowing in order to prevent the production of sexual propagules.

In this study, the canopy height showed a linear increase, and at 174 DAM the reproductive canopy was approximately 80 cm (Figure 5). The plants are typically cespitose, with basal architecture characterized by the leaf production at ground level. No elongation of internodes was observed during the vegetative period. This characteristic is a typical strategy described as "short shoots." Short shoots do not produce significant internode elongation during vegetative growth, and the apical meristem remains below cutting or grazing height, continuing to produce new leaves until it changes to the reproductive phase and the flowering stalk elongates (DAHL, 1995).

Figure 5 - Canopy height of tough lovegrass as function of days of growth after mowing


$$y = 9.320 + 0.387x$$
$$R^2 = 0.98$$
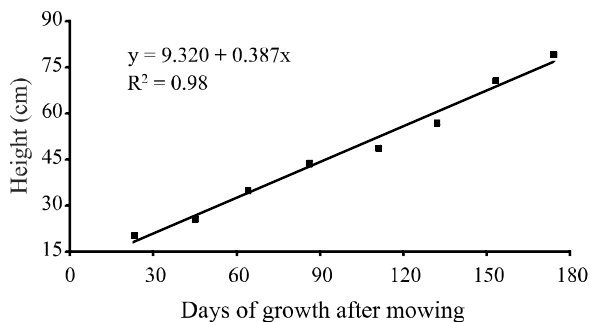
The SLA of tough lovegrass was estimated as 72 cm^2 g^{-1}, which is compatible with the leaf morphology of this grass, whose leaves are narrow. No studies about the physiological attributes of this species are known, but Firn, Prober and Buckley (2012) obtained similar values (60-80 cm^2 g^{-1}) for lovegrass (*E. curvula*). In Australia, this grass invades pastures and roadsides, preferably growing where water and nutrients are scarce resources (FIRN, 2009). The low SLA reduces the carbon uptake by decreasing the photosynthetic surface per unit of DM, suggesting the existence of a trade-off between drought tolerance and

biomass production in this species (BARUCH, 2005). This trait could be one of the features that increase the competition of these two grasses against native grasses in these areas, especially under water deficit. The leaf traits of lovegrass showing lower SLA and higher leaf dry matter content suggesting it has at least a comparable capacity to conserve resources (FIRN; PROBER; BUCKLEY, 2012). When resources are limiting, maximizing leaf longevity by protecting leaf tissue from damage may be favored; in contrast, when resource availability is relatively high following disturbance, high leaf longevity may not be critical.

The LAI increased linearly to a maximum of 2.1 (Figure 6), a value that is negligible compared to that observed in tropical forage grass cultivars. In *Cynodon* spp., Rodrigues *et al*. (2006) obtained an average maximum LAI of 5.8 for plants as young as 42 days. The high LAI of forage grasses with the same productive cycle, such as *Brachiaria* spp. and *Cynodon* spp., favors quick growth and could therefore help to control tough lovegrass invasion.

Figure 6 - Leaf area index (LAI) and leaf area ratio (LAR) of tough lovegrass as a function of days of growth after mowing

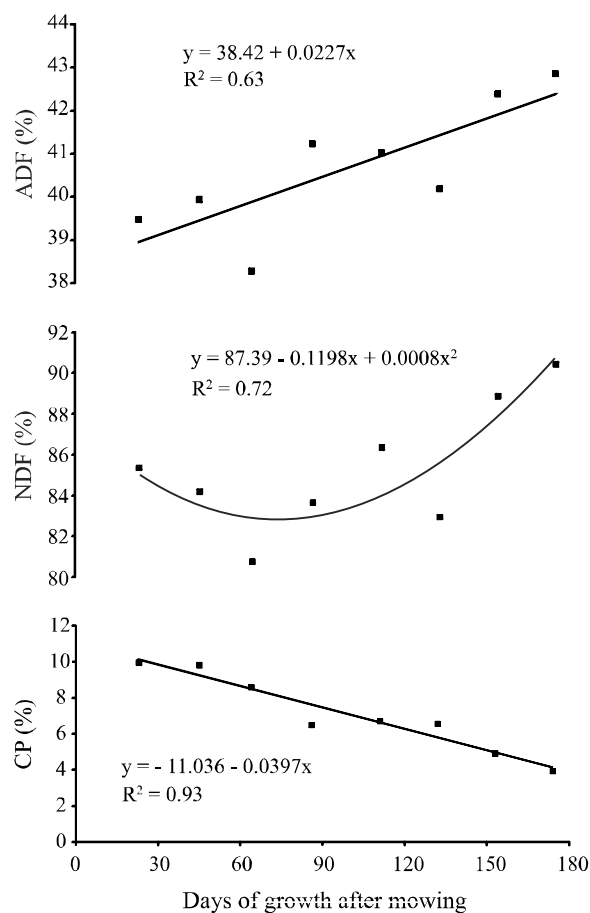$$y = 62.13 + 0.3683x - 0.0026x^2$$
$$R^2 = 0.88$$

$$y = 0.6099 + 0.0069x$$
$$R^2 = 0.70$$
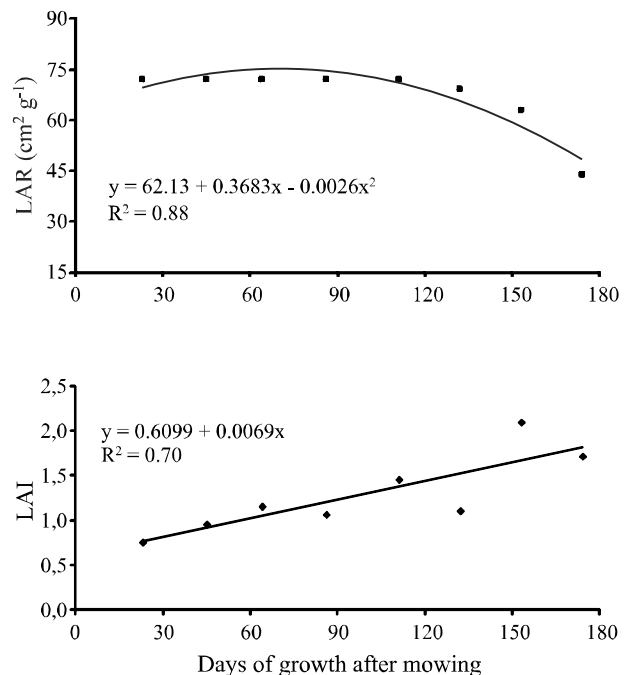
The LAR decreased from 72.2 cm² g^{-1} (23 DAM) to 43.9 cm² g^{-1} (174 DAM; Figure 6). This ratio represents the available leaf area necessary for the plant

to produce 1 g of DM and is one of the main indicators of plant growth. It is a morphological index of the leafiness of the plant, *i.e*, a measure of the 'balance of payments' between 'income' and 'expenditure' because it deals with the potentially photosynthesizing and the potentially respiring components of the plants (HUNT, 1990). Its reduction while the plant is growing is normal because of the development of non-assimilating tissues and structures such as stems and inflorescences, in addition to self-shading, which increases the interference of upper leaves with the lower ones due to plant growth, senescence, and leaf abscission as the plant grows older (URCHEI; RODRIGUES; STONE, 2000). Alexandrino *et al.* (2005) found LAR values between 93 and 167 cm^2 g^{-1} in *Panicum maximum* L., with decreasing rates caused by aging. Rodrigues *et al*. (2006) estimated LAR values close to 200 cm^2 g^{-1} for *B. brizantha*, which is more than twice the values obtained for tough lovegrass in the present study. Therefore, under competitive conditions, it is assumed that grasses with a higher LAR are more competitive against tough lovegrass, as they have a greater relative growth rate.

The forage quality can be assessed by the evaluation of its chemical composition. In this study, the evaluation of the leaves of the tough lovegrass showed a low food quality (Figure 7). The fiber content increased to 90.43% (NDF) and 42.83% (ADF), while CP decreased from 9.96% to 3.94%. Pellegrini *et al*. (2012) verified similar values for these nutritional components in leaves of the tough lovegrass (CP= 6.4-8.9%; NDF= 80.2-82.4%). The bromatological evaluation confirmed the inadequacy of this grass as forage plant, because for ruminants, CP levels lower than 7% are a limiting factor for rumen microorganisms, whereas high fiber levels compromise the consumption and nutrient utilization of the forage plant. As the NDF concentration is positively correlated with the filling of the digestive tract and negatively correlated with energy availability, NDF concentration can be used to express the mechanisms of consumption regulation.

The difficult control of tough lovegrass is associated with its low nutritional value and poor acceptance by animals (ABICHEQUER *et al*., 2009), and the fiber values is a trait related to leaf herbivory. High investment in cell wall material increases the leaf resistance, reduce the digestibility, and have been commonly reported as an effective anti-herbivore defense in terrestrial ecology because it limits the ability of the herbivores to shear or tear the leaves for their intake, and may play an important role in regulating the plant-herbivore interactions reviewed by Santos *et al.* (2012).

Figure 7 - Acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein (CP) of tough lovegrass as a function of days of growth after mowing

$y = 38.42 + 0.0227x$
$R^2 = 0.63$

$y = 87.39 - 0.1198x + 0.0008x^2$
$R^2 = 0.72$

$y = -11.036 - 0.0397x$
$R^2 = 0.93$

CONCLUSIONS

The tough lovegrass presents traits that confer high ability to acquire abiotic resources, high leaf resistance, which is compatible to its high colonization potential and long persistence in invaded grasslands.

REFERENCES

ABICHEQUER, A. D. *et al*. Crescimento e distribuição de raízes de capim-annoni-2 e do campo nativo: vantagem competitiva do campim-annoni-2 **Pesquisa Agropecuária Gaúcha**, v. 15, n. 1, p. 7-12, 2009.

ALEXANDRINO, E. *et al*. Período de descanso, características estruturais do dossel e ganho de peso vivo de novilhos em pastagem de capim-mombaça sob lotação intermitente. **Revista Brasileira de Zootecnia**, v. 34, n. 10, p. 2174-2184, 2005.

BARUCH, Z. *Trachypogon plumosus* (Poaceae), um caso de alta diversidade interpoblacional em sabanas neotropicales. **INCI,** v. 30, n. 8, p. 488-494, 2005.

BARUCH, Z.; HERNÁNDEZ, A. B.; MONTILLA, M. G. Dinamica del crecimiento, fenologia y reparticion de biomasa gramíneas nativas e introducidas de uma sabana neotropical. **Ecotropicos,** v. 2, n. 1, p. 1-13, 1989.

BOGGIANO, P. *et al*. Capim-annoni-2 - *Eragrostis plana* Nees: uma maleza que desvaloriza nuestros campos. **Revista del Plan Agropecuario**, v. 110, n. 1, p. 46-50, 2004.

DAHL, B. E. Development morphology of plants. In: BEDUNAH, D. J.; SOSEBEE, R. E. **Wildland plants**: physiological ecology and developmental morphology. Denver: Society for Range Management, 1995. p. 22-58.

FAGUNDES, J. L. *et al*. Acúmulo de forragem em pastos de *Brachiaria decumbens* adubados com nitrogênio. **Pesquisa Agropecuária Brasileira**, v. 40. n. 4, p. 397-403, 2005.

FIRN, J. African lovegrass in Australia: a valuable pasture species or embarrassing invader. **Tropical Grasslands**, v. 43, n. 1, p. 86-97, 2009.

FIRN, J.; PROBER, S. M.; BUCKLEY, Y. M. Plastic traits of an exotic grass contribute to its abundance but are not always favourable. **PLoS ONE**, v. 7, n. 4, e35870, 2012.

FONTANELI, R. S. *et al*. Predição da composição química de bermudas (*Cynodon* spp.) pela espectroscopia de infravermelho proximal. **Revista Brasileira de Zootecnia**, v. 33, p. 838-842, 2004.

FOY, C. D. *et al.* Adaptation of some introduced *Eragrostis* species to calcareous soil and acid mine spoil. **Communications in Soil Science and Plant Analysis,** v. 10, n. 6, p. 953-968, 1979.

FYNN, R. W. S.; O´CONNOR, T. G. Determinants of community organization of a South African mesic grassland. **Journal of Vegetation Science**, v. 16, p. 93-102, 2005.

HEGAZY, A. K. Growth, phenology, competition and conservation of two desert hygrochastic annuals raised under different watering regimes. **Journal of Arid Environments**, v. 19, n. 1, p. 85-94, 1990.

HUNT, T. **Basic growth analysis**: plant growth analysis for beginners. London: Unwin Hyman Inc., 1990. 112 p.

KATTGE *et al*. A global database of plant traits. **Global Change Biology**, v. 17, p. 2905-2935, 2011.

MACEDO JÚNIOR, G. de L. *et al*. Qualidade da fibra para a dieta de ruminantes. **Ciência Animal**, v. 17, p. 7-17, 2007.

MEDEIROS, R. B.; FERREIRA, N. R. Controle de invasão biológica por capim-anonni em margem viária mediante a introdução de gramíneas. **Revista Brasileira de Zootecnia**, v. 40, n. 2, p. 260-269, 2011.

MEDEIROS, R. B.; FOCHT, T. Invasão, prevenção, controle e utilização do capim-annoni-2 (*Eragrostis plana* Nees) no Rio Grande do Sul, Brasil. **Pesquisa Agropecuária Gaúcha**, v. 13, n. 1/2, p. 105-114, 2007.

PELLEGRINI, C. B. *et al*. Caracterização de pastagem nativa com predominância de *Eragrostis plana* Nees e desempenho reprodutivo de vacas primíparas suplementadas. **Revista Brasileira de Ciências Agrárias**, v. 7, n. 4, p. 697-705, 2012.

RIOS, A. Capin annoni, el aporte de INIA para su control. **Revista INIA**, v. 11, n. 1, p. 17-21, 2007.

RODRIGUES, L. R. A. *et al*. Avaliação de características fisiológicas de cinco cultivares de *Cynodon*. **Acta Scientiarum Animal Science,** v. 28, n. 3, p. 245-250, 2006.

SANTOS, C. B. de los *et al*. Leaf-fracture properties correlated with nutritional traits in nine Australian seagrass species: implications for susceptibility to herbivory. **Marine Ecology Progress Series,** v. 458, p. 89-201, 2012.

SILVA, J. S. O.; HARIDASAN, M. Acúmulo de biomassa aérea e concentração de nutrientes em *Melinis minutiflora* P. Beauv. e gramíneas nativas do cerrado. **Revista Brasileira de Botânica**, v. 30, n. 2, p. 337-344, 2007.

SMITH, M.; KNAPP, A. K. Physiological and morphological traits of exotic, invasive exotic, and native plant species in tallgrass prairie. **International Journal of Plant Sciences**, v. 162, p. 785-792, 2001.

URCHEI, M. A.; RODRIGUES, J. D.; STONE, L. F. Análise de crescimento de duas cultivares de feijoeiro sob irrigação, em plantio direto e preparo convencional**. Pesquisa Agropecuária Brasileira,** v. 35, n. 3, p. 497-506, 2000.

ZENI, R. D.; ZILLER, S. R. An overview of invasive plants in Brazil. **Revista Brasileira de Botânica**, v. 34, n. 3, p. 431-446, 2011.