

**MATURITY AND FERTILIZATION EFFECTS ON LEAF BLADE TISSUE  
PERCENTAGES OF CONTRASTING FESCUE CULTIVARS**

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**Abstract**

Palenque Plus and Ceres Torpedo are tall fescue (*Festuca arundinacea* Schreb.) cultivars available to the animal production systems in the humid Pampean Region of Argentina. They differ in growth cycle and morphological characteristics. At vegetative stage, Torpedo leaves are fine and tender, which suggests that their percentages of slowly digestible and indigestible tissues (SDIT) should be low. In this study we 1) explored the effects of phenological stage and nitrogen fertilization on leaf blade tissue percentages of both cultivars, using an ordination multivariate technique, and 2) evaluated the effects of these factors on the percentage of SDIT. Our results indicate that the analyzed cultivars have different histological responses to fertilization, and maturity. In vegetative stage, Torpedo responds to the fertilization increasing the percentages of live and suberized tissues, and in reproductive stage increasing the percentage of a dead tissue which cells could be lignified. Palenque responds to both factors, maturity and fertilization increasing the percentage of sclerenchyma, but these responses interact. These different

behaviours suggest that the percentage of SDIT would not be a good predictor of the quality in these cultivars in different development stages and fertilization levels.

**Keywords:** Tall fescue, cultivars, histological response, phenological stages, fertilization

## **Introduction**

Tall fescue (*Festuca arundinacea* Schreb.) is a temperate perennial grass broadly distributed in the animal production systems of the Pampean Region of Argentina. In the last 20 years, several temperate and mediterranean cultivars have been incorporated to these systems. Recently, new cultivars of fescue, denominated “flexible” by the texture of their leaves, has been introduced to the region. Although there is enough information concerning the nutritive value of the temperate and mediterranean cultivars, that related flexible type cultivars is reduced. Leaf tissues differ in their resistance to cattle ruminal microbiota (Akin, 1989), so, the percentages of the slowly digestible and indigestible tissues give a good estimation of the forage nutritive value (Akin 1989, Wilman *et al.* 1996, Queiroz *et al.* 1997). Thus, a simple and inexpensive methodology allows an evaluation *a priori* of the nutritive value of the forage species. This study assesses the effects of nitrogen fertilization and phenological stage on the leaf blade tissue percentages of two tall fescue cultivars with different growth cycle, and contrasting morphological characteristics.

## **Material and Methods**

The study was carried out in the Facultad de Ciencias Agrarias (UNMDP) at Balcarce (37°45'S, 58°18'W) with leaf blades from two cultivars of tall fescue (*Festuca arundinacea* Schreb.): Palenque Plus (PP) of temperate origin, and Ceres Torpedo (CT) of flexible type,

whose responses in quality to nitrogen fertilization and maturity differ. Cultivars were separately sowed in contiguous plots, in an argiudol soil with good drainage. Each plot was divided in twelve 7.5 m<sup>2</sup>, and six of them were randomly fertilized with 150 kg . ha<sup>-1</sup> of UREA. At each stage of development biomass of 3 fertilized and 3 no-fertilized subplots was harvested from each cultivar.

Sampling dates were: Palenque = 09/09 and 10/21, and Torpedo = 10/21 and 11/3/1997 , for the vegetative and flag leaf stages, respectively. At each sampling date we randomly harvested 30 tillers in each sub-plot for anatomical analysis. From the vegetative tillers, we took the second and the third leaves, and from the tillers at flag leaf stage we took the third and fourth leaves. Later, we cut the central 2-3 cm portion of each leaf, and estimated the percentages of the different tissues in cross sections obtained from these portions. We drew the leaf anatomy in cross section using a microscope with camera lucida. Drawings were processed using AutoCAD R12 and a Genius 1812 graphic table, and the tissue percentages were determined using the software ArcCAD. Finally, leaf tissues were grouped in rapidly (phloem, parenchyma+ chlorenchyma, and bulliform cells), and slowly plus indigestible (SDIT; upper and lower epidermis, sclerenchyma, xylem, and vascular sheaths). Variation in tissue percentages among leaf samples was explored by Principal Component Analysis (PCA). The variation in the percentages of SDIT was analyzed by ANOVA with a factorial design with cultivar, development stage and fertilization as factors.

## **Results and Discussion**

The response to nitrogen fertilization on the percentages of different leaf tissues differed among cultivars, stages of development, and levels of fertilization. The main source of variation among blade leaf samples was related to the contrast between the highest percentages of

parenchyma+chlorenchyma in Torpedo leaves from plants at vegetative stage without fertilization, and the highest percentages of upper epidermis and vascular sheaths in the rest of the samples (Fig. 1, see CP1 which explains 42 % of the variance among samples). The percentage of parenchyma+chlorenchyma in Torpedo leaves from vegetative no-fertilized plants was 30 % higher than that in the rest of the samples (68.1±1.0 vs 52.5±3.6%). These high percentages in parenchyma+chlorenchyma could explain the texture of the Torpedo leaves in vegetative no-fertilized plants, which are fine and tender, looking like perennial ryegrass leaves. On the other hand, fertilization determined an increment in sclerenchyma percentages in Torpedo leaves from plants at flag leaf stage, as well as in the Palenque leaves in plants at vegetative stage. However it did not produce consistent changes in the percentages of leaf tissues in Palenque leaves from plants at reproductive stage, because of the great variability in the percentages of sclerenchyma among samples (see Figure 1, PC2 that explains 21% of the variance).

The passage from vegetative to reproductive stage in leaves of Torpedo no fertilized plants increased the percentages of upper epidermis and vascular sheaths. This also happened, although in less extent, in leaves of Torpedo from fertilized plants (Figure 1, see CP1). However, in Palenque samples, the effect of the change of development stage was not clear, because it interacted with fertilization level. The percentages of sclerenchyma in vegetative fertilized plants overcome those registered in the reproductive stage (Figure 1, see CP2).

The response in percentages of SDIT of each cultivar to changes in the stage and fertilization was different (interaction cultivar x fertilization;  $p < 0.01$ ). In Palenque, the percentage of SDIT increased 11% from vegetative to reproductive stage (33.8 vs 37.7%;  $p < 0.05$ ) (Figure 2a), and it did not change with fertilization ( $p > 0.05$ ). On the contrary, in leaves of Torpedo from no fertilized plants, the percentage of these tissues increased 49% from vegetative

to flag leaf stage (25,3 vs 41,2%;  $p < 0.01$ ), while its level remained high and stable in the leaves from no fertilized plants in both development stages (40%;  $p > 0.05$ ) (Figure 2b).

The association of most of the samples with the positive extreme of CP1 (Figure 1), and the high percentages of SDIT found, except in leaves of Torpedo vegetative non fertilized plants (Figure 2b), are related to the intermediate-low values of digestibility cited for tall fescue in the literature (Sleper and West 1996).

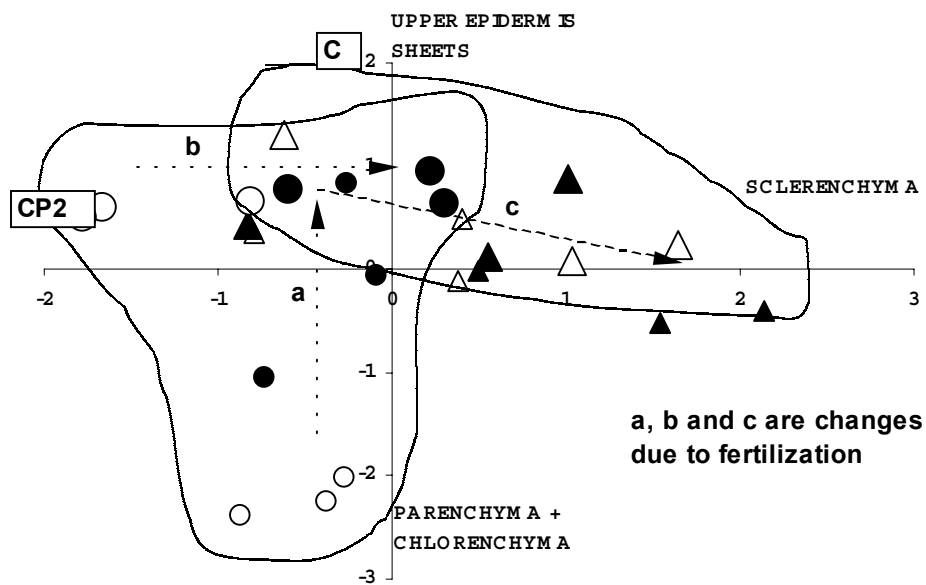
Our results indicate that the analyzed cultivars of tall fescue has different histological responses to nitrogen fertilization, and maturity. In vegetative stage, Torpedo responds to fertilization increasing the percentages of live and suberized tissues (epidermis and vascular sheaths), and in reproductive stage increasing the percentage of a dead tissue which cells could be lignified (sclerenchyma). Palenque responds to changes in stage and fertilization increasing the percentage of sclerenchyma, but the responses to these two factors interact. These different behaviours suggest that the percentage of SDIT would not be a good predictor of the quality in these cultivars in different development stages and fertilization levels.

### References

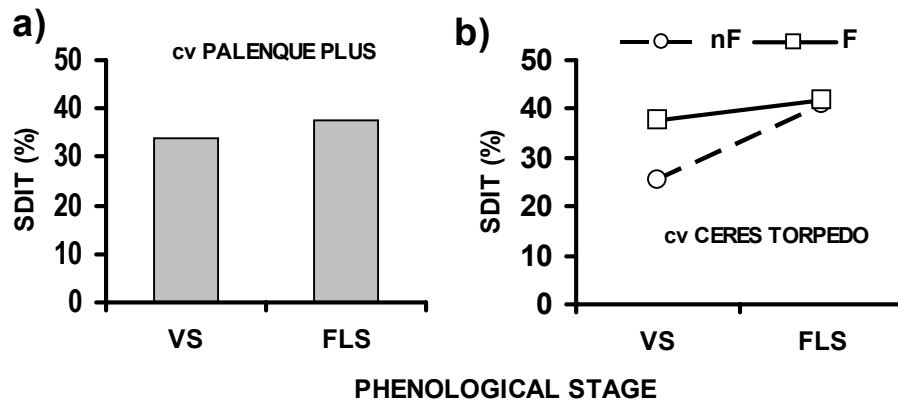
- Akin, D.E.** (1989). Histological and physical factors affecting digestibility of forages. *Agronomy Journal* **81**: 17-25.
- Queiroz, S., Gomide J.A. and María J.** (1997). Anatomic and chemical traits, and in vitro digestibility of three tropical grasses. *Proceedings XVIII International Grassland Congress*, **2**:85-86.
- Sleper, D.A. and West C.P.** (1996). Tall Fescue. In: Moser L.E., Buxton D.R. and Casler M.D. (eds) *Cool-Season Forage Grasses*. *Agronomy*, **34**:471-502. American Society of

Agronomy/Crop Science Society of America/Soil Science Society of America, Madison, Wisconsin, USA.

**Wilman, D., Mtengeti E.J. and Moseley G.** (1996). Physical structure of twelve forage species in relation to rate of intake by sheep. *Journal of Agricultural Science* **126**:277-285



**Figure 1** - Scatter diagram on the leaf blade samples from two tall fescue cultivars : Palenque Plus (  $\Delta$  ) and Torpedo (  $\circ$  ). White = vegetative, and black = flag leaf stages. Small figures = without fertilization. Big figures = with fertilization. Arrows indicate fertilization.



**Figure 2** - Variation in the percentages of slowly digestible plus indigestible tissues (SDIT) in two contrasting cultivars of tall fescue at two phenological stages, and with two levels of nitrogen fertilization (0 = nF, and 150 kg . ha<sup>-1</sup> of UREA = F).