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Correlations among anatomical, morphological, chemical and agronomic characteristics of leaf blades in *Panicum maximum* genotypes

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ABSTRACT

Tropical forage grasses present high growth rates and biomass yields, partly due to its C_4 photosynthetic pathway. Considering this, the anatomy of the grasses related to morphology and chemical composition of leaf blades may influence consumption and digestibility, thus interfering in the forage quality. Agronomic, morphological, anatomical and chemical characteristics of leaves of nine *Panicum maximum* genotypes were evaluated in Brazil, to verify if these characteristics and the associations among them may influence the quality of the leaf blades. A randomized complete blocks design was used with nine treatments and three replications. Three evaluation harvests were done in the rainy season and one in the dry season to evaluate forage yields and quality. Quality was determined through NIRS – Near Infrared Spectrometer. One day prior to each harvest, four leaf blades per plot were harvested for morphological and anatomical evaluations. Results were subjected to analysis of variance and mean comparison by Tukey test, and to simple linear and canonical correlations by SAS. Leaf width was positively correlated with mesophyll. The parenchyma bundle sheath was associated with leaf area and specific leaf area. Neutral detergent fibre was positively correlated with the parenchyma bundle sheath area and specific leaf area. The specific leaf area was negatively correlated with *in vitro* organic matter digestibility. Morphological differences among *P. maximum* genotypes did not interfere in biomass accumulation. Considering this, leaf width may be a supplementary tool, that may be used in the early phases of the process of genotype selection, for discriminating qualitatively promising high yielding materials.

Abbreviations: ABAep, abaxial epidermis; ADAep, adaxial epidermis; ADF, acid detergent fibre; CEL, cellulose; CP, crude protein; L_A, leaf area; LBGDM, leaf blade green dry matter; L_L, leaf length; Lignin (sa), lignin determined by solubilization of cellulose with sulphuric acid; L_W, leaf width; MES, mesophyll; NDF, neutral detergent fibre; OMD, organic matter digestibility; PBS, parenchyma bundle sheath; SCL, sclerenchyma; SIL, silica; SL_A, specific leaf area; SSGDM, stem and sheath green dry matter; TDM, total dry matter; VT, vascular tissue.

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1. Introduction

In tropical areas, the major grasses used as forage for cattle belong to the genus "*Brachiaria*" or "*Panicum*", which are widely distributed and well adapted to most tropical areas. However, considering that tropical grasses are of lower nutritional value compared to those from temperate areas, it is important to identify tropical grass varieties with the highest nutritive value.

Forage quality is based on the composition of digestible or fermentable compounds and forage consumption by ruminants (Mott and Moore, 1970). Forage nutritive value is highly associated with leaf blade anatomy, as well as with their tissues, considered individually (proportion of the transversal section) or combined. This occurs because some tissues are highly digestible while others are poorly digestible or even indigestible; thus, the relative quantity of these tissues determines forage quality. In fact, high digestibility forage has been associated to tissues with high soluble compound concentration and a thin cell wall (Wilson, 1993).

Considering that some forage tissues improve while others impair digestibility (Akin, 1989), analyses of the proportions between these tissues should indicate the forage digestibility potential. This expectation is reinforced, given that rapidly degrading tissues are positively correlated with digestibility coefficients, and negatively associated with cell wall rigidity and lignin levels (Queiroz et al., 2000; Wilson et al., 1983).

In addition to associations between leaf blade digestibility and anatomy (tissue proportion) and cell wall content (which determines cell wall rigidity), strong linear associations between forage digestibility and morphological (L_L, L_W, L_A and SL_A), chemical, and anatomical forage attributes have been described (Wilson and Hattersley, 1989; Wilson et al., 1989; Casler and Carpenter, 1989; Masaoka et al., 1991). These multiple factors suggest that more adequate multivariate correlations should be found. Thus, the present study was designed to identify the multifactor relationships using canonical association tests on agronomic, chemical, morphological and anatomical characteristics of forage leaf blades, that could affect nutritive value of the tropical forage grass *Panicum maximum*.

2. Materials and methods

2.1. Plant material

The experiment was carried out at Embrapa Beef Cattle, Campo Grande, MS, Brazil (530 m asl, 20°27′S and 54°37′W). The soil was dark-red latosol, with a clay content of 400–450 g clay/kg soil. Based on soil analysis, it was corrected by adding 2 tons of dolomitic limestone/ha^{-1}, and fertilized with 100 kg/ha P_2O_5 applied as simple superphosphate, 40 kg/ha K_2O as potassium chlorate, and 50 kg/ha FTE BR16, a micronutrient mixture. Genotypes were sown in November 2002 with 3.3 kg/ha pure live seed. In February 2004, top-dressing fertilization was carried out with 100 kg/ha P_2O_5 as simple superphosphate, 100 kg/ha nitrogen as urea, and 100 kg/ha potassium as potassium chlorate.

Nine *P. maximum* genotypes were selected from the II National Network Evaluation, where 23 genotypes were evaluated in five Brazilian regions (Jank et al., 2005). These plants were visually selected for low height [erect (PM31) and decumbent (PM45 and Aruana) leaf blades]; medium height [erect (PM37), and decumbent (PM44 and PM43) leaf blades]; and high height [erect (PM33 and Milênio) and decumbent (PM47) leaf blades]. The experimental design was a randomized blocks design with three replications. Each genotype grew on 12 m^2 plots consisting of six 4 m long rows, with a distance of 0.50 m between rows and 2 m between plots. Plants were cut to a uniform 20 cm height on 11 November 2004. Evaluation cuts were done three times every 35 days in the rainy season and once in the dry season (42 days after the last cut). Leaf blades for anatomical analyses were harvested one day before each forage evaluation cut.

2.2. Experimental strategy

The experiment consisted of quantifying the morphological, anatomical, chemical and agronomic variables of the leaf and studying the correlations among these variables. The variables in each category were:

Agronomic variables (kg/ha): TDM, total dry matter; LBGDM, leaf blade green dry matter; SSGDM, stem and sheath green dry matter.
Chemical variables (g/kg DM): CP, crude protein; NDF, neutral detergent fibre (NDF assayed without a heat stable amylase, with sodium sulfite, and not corrected for ash); ADF, acid detergent fibre (ADF and not corrected for ash); OMD, organic matter digestibility; lignin (sa), lignin determined by solubilization of cellulose with sulphuric acid; CEL, cellulose; SIL, silica; OM, organic matter.
Morphological variables: L_L, leaf length (cm); L_W, leaf width (cm); L_A, leaf area (cm^2); SL_A (specific leaf area) = [leaf area (cm^2)]/[leaf dry weight (g)].
Anatomical variables (relative tissue proportion): ADAep, adaxial epidermis; ABAep, abaxial epidermis; VT, vascular tissue; PBS, parenchyma bundle sheath; SCL, sclerenchyma; MES, mesophyll = total area of the cross section – area of each tissue.