Scientific Paper

Forage potential of four cultivars of Pennisetum purpureum *on a Grayish Brown soil of Las Tunas*

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ABSTRACT: In order to evaluate the productive performance of four cultivars of *Pennisetum purpureum* (King-grass, Cuba CT-169, Cuba CT-115 and Taiwán morado), an experiment was conducted on a Grayish Brown soil, at the Pasture and Forage Research Station of Las Tunas (Cuba). The soil was prepared with minimum tillage, and a planting distance of 0,90 m between rows and 0,60 m between plants was used. The age of the seed used was 90 days and the planting depth, from 15 to 20 cm. The study was conducted during two years, with neither irrigation nor fertilization. A randomized block design was used, with five replications. The growth dynamics showed a similar pattern in all the cultivars, and Cuba CT-169 stood out. The greatest height in the first year was reached during the period May-July, and in the second year, in July-September. In the first year there were not differences in the DM yield among the cultivars, in the same season; while in the second year there were significant differences during the rainy season and the annual total, and CT-169 differed significantly from the rest (37,7 and 43,8 t DM/ha, respectively). During the dry season the cultivars had a similar performance. The percentage of leaves did not differ in both seasons of the first year; while in the second year the cultivars showed significant differences during the dry season, and the CT-169 exceeded the rest in 3 to 5 percentage units. It is concluded that under the edaphoclimatic conditions of this study cv. CT-169 had a better performance.

Key words: evaluation, CT-169, CT-115, King-grass, minimum tillage, Taiwán morado, yield

INTRODUCTION

The main problem of tropical livestock lies in animal feeding during the dry season. In Cuba, this critical period can last from four to seven uninterrupted months (Lok *et al.,* 2009), in which the yield of tropical pastures and the continuity of the productive process decrease considerably, and this causes the weight loss and death of the animals (Martínez, 2001).

However, it is known that pastures and forages are the most suitable feeding source for cattle, due to the high number of species, their ecological plasticity and their possibility to continuously grow throughout the year. The designs of technological alternatives for cattle production systems in the tropic also include the introduction of forage germplasm as one of the main ways to increase the productivity of livestock agroecosystems (Paretas and González, 1990; Ramírez *et al*., 2004).

The most widely used forage species in Cuba, after sugarcane, is *Pennisetum purpureum,* due to its high biomass production and its good proportion of leaves. Besides, for its rusticity and plasticity it adapts to a great diversity of soils (including the low-fertility ones), and to adverse climate conditions (high temperatures and low rainfall). Therefore, the objective of the study was to evaluate the forage potential of four *P. purpureum* cultivars under the edaphoclimatic conditions of Las Tunas.

MATERIALS AND METHODS

Location. The experiment was conducted at the Pasture and Forage Research Station of Las Tunas –belonging to the Network of Stations of the Pasture and Forage Research Institute of the Cuban Ministry of Agriculture–, which is located in the Las Tunas-Bayamo road, at 20°54' North latitude and 76°55' West longitude, at a height of 50 m.a.s.l.

Soil. The soil of the experimental area is classified as Grayish Brown (Hernández *et al*., 1999), and it has low effective depth, low fertility, low water retention, slightly acid pH and slightly undulated topography. Table 1 shows the chemical composition of the soil used in the research.

Table 1. Chemical composition of the soil.

Indicator	Content
K^+ (cmol/kg)	0,26
Na^+ (cmol/kg)	0,04
Ca^{++} (cmol/kg)	6,2
Mg^{++} (cmol/kg)	3,3
P_2O_5 (mg/100g)	2,01
K_2O (mg/100g)	4,02
OM (%)	1,9
pH in H_2O	5,7

Climate. In comparison to the historic mean (last 11 years), dry seasons were very severe; while the temperature and the relative humidity of the air did not varied with respect to the historic mean (table 2).

Treatments and design. A randomized block design was used, with five replications and four treatments, which were constituted by four cultivars of the species *P. purpureum*: King grass, Cuba CT-169, Cuba CT-115 and Taiwan morado. The experiment lasted two years.

Experimental procedure. The preparation of the soil was made with minimum tillage, as it is a master soil without great weed infestations; for such purpose, a tractor Yum-6m and a harrow of 2 200 p were used, and the area was harrowed twice. The plowing was made with an ox team and mouldboard plow.

The planting distance was 0,90 m between rows and 0,60 m between plants, and 11 double propagules were planted in each row, for which each plot was composed by 44 seedlings. The propagule size was from 25-30 cm, and each one had from three to five buds per stem. The age of the seed used was 90 days and the planting depth, from 15 to 20 cm. The seeds were covered with a hoe, with a soil layer from 3 to 5 cm.

The plots had a total area of 28 m² (7 m long by 4 m wide), with a separation of 1 m between them, and they were constituted by four rows. The two corresponding plows to the external parts of the plots were discarded, to eliminate the edge effect; therefore, the calculation area of each plot was of 14 m².

The cutting frequency was 60 days during the rainy season (RS) and 90 days during the dry season (DS). All the cuttings –five per year (two during the DS and three during the RS) – were made at soil level. After each cutting, cultivation activities with oxen and weeding with hoe, were performed.

Measurements. The height was determined with a rule graduated in centimeters that was placed next to the plant perpendicular to the soil, from the surface of this one to the bending of most leaves, in addition to the DM yield; the leaf percentage and the number of shoots per plantlet.

The data were processed with the statistical pack Software Estadística, version 2.0, of the Institute of Animal Science (1998). Duncan's Test (1955) was used for mean comparison.

RESULTS AND DISCUSSION

One of the studied variables in this research was the height of the forage, because it is one of the components of yield. Some researchers have used it to indicate crop growing and yield. In this sense, Olivera (2004) used it to characterize some *Brachiaria* spp. accessions, Noda (2006) informed that such variable influenced positively the DM yield of *Morus alba*, while Martínez *et al*. (2010) found properly adjusted equations between the height and the DM yield.

In the first year (fig. 1) the growth dynamics showed a similar pattern in all the cultivars, and Cuba CT-169 stood out slightly. In general, the greatest height was reached in the period May-July.

Table 2. Performance of some climate indicators.

Year	Season	No. of days with rain	Rainfall (mm)	Average temperature (°C)	Relative humidity (%)
1st. year	Dry	7	32	23,1	74
	Rainy	37	860	26,6	80
2nd. year	Dry	6	93	23,7	76
	Rainy	51	1050	26,7	82
Historic mean	Dry	7	179	23,8	74
	Rainy	35	924	26,5	79

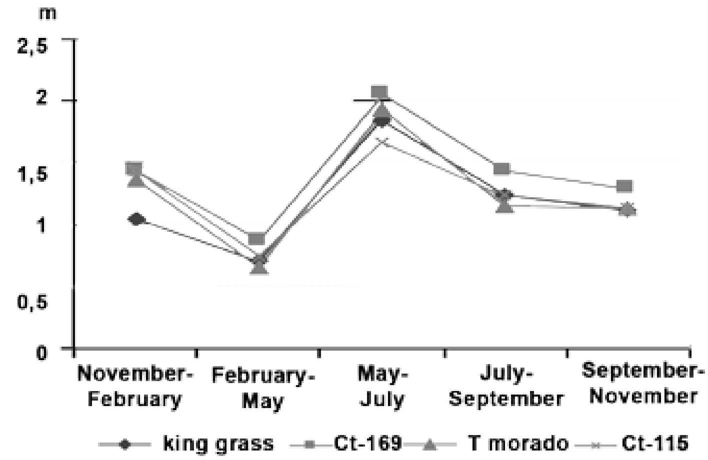

Figure 1. Plant height (m) at the moment of cutting. Year 1.

During those months rainfalls of 200 mm were recorded, the average temperature was 26,4 ºC and the relative humidity, 79 %; for which the growth and development conditions of the crop were favorable.

Meanwhile, in the second year (fig. 2) the cv. Cuba CT-169 stood out regarding growth throughout the experimental stage. The period of higher growth was July-September, which could be related to the rainfall (312 mm). Also, in this season the plantations could have received the higher amount of light hours to perform the photosynthetic functions.

This result coincides with the report by Martínez *et al.* (2010), who found that CT-169 showed a high size and fast growth, and by Caballero (2013), who obtained a greater height in the accession CT-169, without significant differences from king grass and CT-115.

The results obtained by Lok *et al.* (2009) regarding the height of king grass in a biomass bank of this species were higher than the ones obtained in this work, maybe due to the differences that existed with regards to soil fertility, as well as to the rainfall regime and other environmental conditions, during the RS as well as the DS.

Regarding the DM yield, there were no significant differences among the cultivars in the same season, during the first year of evaluation (table 3). Nevertheless, the yield of the cv. Cuba CT-169 tended to be higher.

In the second year of evaluation (table 4), the cv. Cuba CT-169 differed significantly from the other treatments in this indicator, which was manifested in the RS and in the annual total. This corroborates the report made by Martínez *et al.* (2010) with regards to the relation between height and yield,

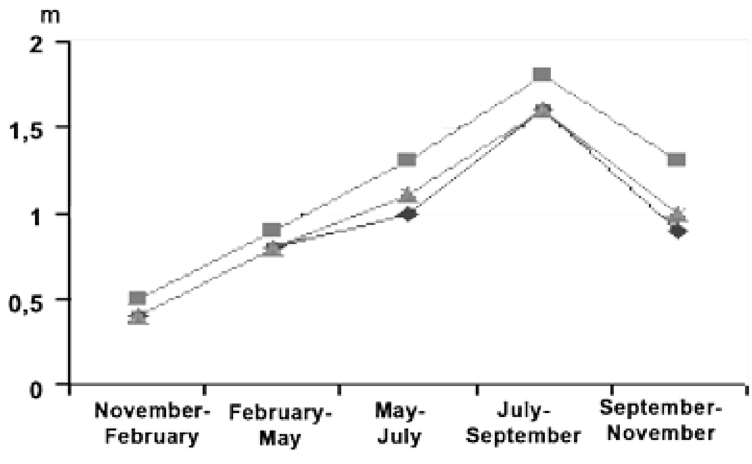

Figure 2. Plant height (m) at the moment of cuttting. Year 2.

Table 3. DM yield of the *P. purpureum* cultivars. Year 1.

Treatment	DM yield (t/ha)		
	RS	DS	Total
King grass	15,2	3,8	19,0
Cuba CT-169	17,1	6,0	23,1
Taiwán morado	13,5	5,2	18,7
Cuba CT-115	14,8	4,2	19,1
SE ±	1,5	0,7	1,7

Table 4. DM yield of the *P. purpureum* cultivars. Year 2.

Treatment	DM yield (t/ha)		
	RS	DS	Total
King grass	24,3[a]	4,7	29,0[a]
Cuba CT-169	37,7[b]	6,1	43,8[b]
Taiwán morado	26,7[a]	5,2	31,9[a]
Cuba CT-115	25,2[a]	5,1	30,6[a]
SE ±	2,0*	0,4	2,1**

Means with different letters differ significantly at $p < 0,05$
$^*p < 0,05$; $^{**}p < 0,01$

because the height of this cultivar surpassed the rest and its yield was higher than 40 t/ha. In the dry season all the cultivars had a similar performance.

In the second year the yields were higher in all the cultivars, as occurs in most grasses, mainly because the root system deepens with the age of the plantation and, in addition, as the rainfall was higher in this year. In such sense, the studies conducted by Lok *et al.* (2009) showed that the genus *Pennisetum* has the species of higher root development, because their roots explore up to 30 to 50 cm of depth.

The leaf percentage of the different cultivars of this species (table 5) did not show significant differences in both seasons of the first year. In the RS this indicator was higher with respect to the DS.

In the second year of evaluation (table 6), the cultivars showed significant differences ($p < 0,05$) regarding the leaf percentage only during the DS and the cv. Cuba CT-169 surpassed the rest in 3-5 percentage units. This fact is greatly important, because it can imply that the protein and digestibility values are higher when this forage is supplied to the animals; because, according to Chacón and Vargas (2009), the materials with a higher leaf proportion have a higher nutritional value. During the RS there were no significant differences, in correspondence with the results obtained by Martínez *et al.* (2009).

The higher amount of leaves in the cv. Cuba CT-169, in both seasons and years of evaluation, coincides with the report by Herrera and Martínez (2006); who state that such cultivar exceeds the king grass in 8-10 percentage units of leaves, and that they are wider and larger.

According to Chamorro *et al.* (2011), the number of leaves in the grasses is related to the photosynthetic capacity and to a higher concentration of nutrients, which allows the plants to reach higher productivity. This explains the results reached in the cv. Cuba CT-169.

Another important aspect was the number of shoots per plantlet in the four cultivars of *P. purpureum*, indicator that showed significant differences during the two years of evaluation (table 7) among the cultivars.

In the DS, in both years of evaluation, the cv. Cuba CT-115 showed the lowest shoot production, and differed from the rest. On the other hand, during the RS of the first year the cv. Cuba CT-169 showed the highest shoot production, without differing from Taiwán morado; while in the second year it differed from the other cultivars.

In general, the shoot production was low in all the cultivars, which could be related to the planting frame used. In this sense, Crespo (2006) reported from 30 to 40 shoots per plantlet, but with the use of a higher planting distance.

Table 5. Leaf percentage of the cvs. of *P. purpureum*. Year 1.

Treatment	Leaf percentage	
	RS	DS
King grass	43,6	35,7
CT-169	44,5	36,6
Taiwán morado	44,3	34,2
CT-115	42,3	31,0
SE ±	4,4	5,1

Table 6. Leaf percentage of the cvs. of *P. purpureum*. Year 2.

Treatment	Leaf percentage	
	RS	DS
King grass	35,8	50,0^{b}
Cuba CT-169	43,0	53,0^{a}
Taiwán morado	38,6	48,8^{b}
Cuba CT-115	38,4	48,2^{b}
SE ±	1,3	0,8*

Different letters in the same column differ significantly at $p < 0{,}05$; $*p < 0{,}01$

Table 7. Number of shoots per plantlet in the evaluated cultivars.

Treatment	Number of shoots per plantlet	
	RS	DS
First year		
King grass	11,7^{c}	18,1^{a}
Cuba CT-169	13,9^{a}	17,7^{a}
Taiwán morado	13,5^{ab}	17,8^{a}
Cuba CT-115	13,1^{b}	15,0^{b}
SE ±	0,2 *	1,0 **
Second year		
King grass	10,2^{d}	13,6^{ab}
Cuba CT-169	15,4^{a}	17,6^{c}
Taiwán morado	12,8^{b}	14,2^{b}
Cuba CT-115	11,6^{c}	12,6^{a}
SE ±	0,3**	0,4**

Different letters in the same column differ significantly at $p < 0{,}05$; $*p < 0{,}05$; $**p < 0{,}01$

According to Da Cunha *et al*. (2011), the species *P. purpureum* has a high variability and its genotypes show distinctive morphologic and productive characteristics. In this sense, and according to the results previously exposed, it can be concluded that the cv. Cuba CT-169 made a most efficient use of the available resources and showed a better performance under the edaphoclimatic conditions of Las Tunas.

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