Yield and chemical composition of CT-115 (*Pennisetum purpureum*) pasture established at two densities and in two sowing dates in Marín, Nuevo León, Mexico

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The yield and content of nutrients was assessed in leaves, stems and dead material of *Pennisetum purpureum* cv. Cuba CT-115 sown at two densities (D1=17850 and D2=11350 plants/ha) and on two sowing seasons (late and early) in the northeast of Mexico. The sowing was conducted considering a completely random design, with factorial arrangement 2 x 2 x 3 and on July-August (early season) and September-October (late season) of 2009. Sixteen experimental plots in a total area of 900 m^2 were used. Seven sprouts per experimental unit were randomly sampled, 45 d after the regrowth during May of 2010. The variables were yield (t/ha), cell content, CP, NDF, ADF, hemicellulose and *in vitro* organic matter digestibility. The production of leaf, stem and dead material (t/ha) had significant differences ($P < 0.01$) and the values were 2.65, 1.84 and 0.74, respectively. The CP content was higher ($P < 0.05$) in leaf and stem (11.3 and 10.04 %) compared with the dead material (6.01 %). The ash content was higher ($P < 0.05$) in both sowing seasons, with range between 14.5-20.9 % for the different morphological components. The digestibility was of 63.6 %. It is concluded that the pasture CT-115 (*Pennisetum purpureum*) had good quality and may be considered an alternative for cattle feeding in the northeast of Mexico.

Key words: *Pennisetum purpureum CT 115, chemical composition, sowing density, sowing date, dry matter production*.

The cattle producers in the northeast of Mexico depend on native summer pasturing and grasslands established mainly of Buffel grass (*Cenchrus ciliaris*) pasture (Saldívar *et al*. 2004). Under these conditions, forage production is reduced during winter or the dry season, so producers use hay forage bales of the same species and, sometimes, of Bermuda grass (*Cynodon dactylon*) var. NK-37 and coast cross[2] Bermuda grass (Tifton 68) to feed cattle. Besides, they use sorghum grains and their EQUILMOS, maize wastes and, in extreme situations, nopal. The blaes or wastes are not of good quality, so the producers and farmers have used other species such as Taiwan (*Pennisetum purpureum*) pasture, Pretoria 90 (*Dichanthium annulatum*), coast cross[2] Bermuda grass and Klein (*Panicum coloratum*), among others. However, their yield is not always high. For example, the Buffel grass, with fertilization and irrigation, reached values of 7.3 t DM (García *et al*. 2007) with 8.6 % CP (Faría and Sánchez 2007) and of 8 % (Ramírez *et al*. 2004). In the variety Klein, the reports have been of 9.7 % (Ramírez *et al*. 2002), Pretoria 90 6.6 % (Ramírez *et al*. 2005) and 10.5 % in Bermuda Tifton 68 (Ramírez *et al*. 2003).

At present, there are different options of forage species tolerant to draught that with proper rainfall during the rainy season may produce high forage yield with acceptable quality. Several genotypes of *Pennisetum purpureum* are included in these varieties. The different species of Pennisetum genre are promising for cattle rearing. Generally, they have green matter yields superior to 40 t/ha in each cut and 120 t/ha/year (Martínez *et al*. 1994) and 11.4 % of CP (Valenciaga *et al*. 2001). The clone CT-115 was obtained in Cuba, with higher possibilities of use in direct grazing due to its short height, acceptable yield and quality (Martínez *et al*.1996).

The objective of this study was to assess the yield and chemical composition of CT-115 (*Pennisetum purpureum*) pasture, sown at two densities and two sowing seasons in Marín, Nuevo León, Mexico.

Materials and Methods

The experiment was conducted in the Experimental Field of the Agronomy Faculty from the Autonomous University of Nuevo León, located in Marín, N.L., Mexico, which geographical coordinates are: 25° 25' 27" N and 100° 03' 19" W, with altitude of 393 m a.s.l. The weather is extreme, with rainfall and annual average temperature of 528 mm and 22 ºC, respectively (Tmax= 42 ºC and Tmin= -10 ºC).

The sowing of CT-115 was conducted from July to October 2009. The climatic factors (maximum, minimum and mean temperature, rainfall and relative humidity) were determined to assess the effect of the sowing density and season in 2009-2010. The highest rainfall was recorded in September. January was the coldest month, highlighting the 9th and 10th days for having minimum temperatures of -6 ºC (table 1) (De la Fuente 2010).

Treatments, experimental design and procedure. Sixteen experimental plots of 15 x 15 m were established. The soil was prepared with a ploughing and two harrowings. Half of the plots were sown from July 20th to August 20th, as early season and the rest during September and October, considered as late

Table 1. Monthly average of temperatures (maximum, minimum and average), rain and relative humidity in the area of study (July 2009-June 2010)

Date	Rain, mm	Temperature, ºC			Relative humidity, %
		Maximum	Minimum	Average	
July 2009	4.4	39.5	24.4	31.2	51.2
August	70.0	39.0	23.5	30.7	50.4
September	138.0	31.7	21.0	25.4	76.4
October	45.6	28.7	17.9	22.7	74.7
November	21.6	26.0	10.1	17.8	64.1
December	30.2	19.7	7.3	12.7	78.2
January 2010	40.0	20.0	6.5	12.9	69.0
February	21.0	20.8	6.8	13.4	67.3
March	14.2	27.4	9.6	18.8	55.2
April	106.4	29.9	17.2	23.2	60.1
May	20.8	34.2	20.6	27.0	50.2
June	89.2	37.3	23.6	29.6	55.3

season. Two plantation densities (D1=17850 and D2= 11350 plants/ha) were sown in the plots of each date. The pasture stems cut in segments of three buds were used. The sowing was conducted by placing the vegetative seed, of at least five months of age, in the bottom of the furrow, covering it with a soil layer of 10 cm. According with the treatment, the same number of buds per plot was always planted.

At the sowing time, the soil was irrigated with well water with electric conductivity of 2.9 mS, with low sodium and sodium carbonate. The irrigations were repeated every 7 d during 21 d to guarantee the emergency. Later, the crop only received the rain water.

A cutting was conducted in January for the plots of the first sowing due to their growth. However, they were affected by the low temperatures (-6 ºC) recorded in this month. The regrowth occurred from March 2010 on. The establishment cut was carried out on May 5, 2010 by cutting the bunch at 10 cm above the soil level. Seven bunches were randomly selected from each experimental plot to measure the variables of interest. This represented a sampling area of 5.6 m² and 7.7 m² for D1 and D2, respectively, according to the suggestions of Herrera (2006), who refers that the sampled area should not be inferior to 0.1 % of the total area.

The samplings were carried out between the 08:00 and 12:00 h. The samples were weighed with a digital balance, with maximum capacity of 20 kg and minimum division of 0.01 kg. After weighing the total forage of the seven bunches, sub-samples were collected to separate them into the three main morphological components of the grasses: leaves, stems and dead material (Herrera 2006). The samples were dried in an air-circulation oven at 60 ºC to calculate the percent of DM of the whole plant, stems, leaves and dead material, variables used to estimate the DM production of each component per hectare.

The samples were milled with a Wiley miller. They were sifted at particle size of 1 mm to determine later their chemical composition and obtain the ash content (AOAC 1995) and the nitrogen percentage used by the combustion method (Etheridge *et al*. 1998 and Figenschou *et al*. 2000) in the Truspec CHN equipment of LECO. This way, the CP content (6.25 x N) was estimated. The NDF and ADF contents (van Soest *et al*. 1991) were analyzed according to the technological modification of ANKOM 2000 (Automated Fiber Analyzer). The hemicellulose content was calculated as NDF-ADF (Dryden 2008). The *in vitro* organic matter digestibility was determined according to Kesting (1977).

Before the sowing, 10 soil samples were taken at 15 cm depth to obtain one composed of 1 kg. They were analyzed for pH, OM, N, P, K, Ca, Mg and salinity (Rodríguez 2002). The results of the soil analysis showed that it is of clayish texture, with 7.8 of pH, lightly alkaline, with fairly poor OM content (1.71 %) and values of nitrogen, phosphorous, potassium and soluble salts of 0.134 %, 64.3 ppm., 1.42 meq/100 g and 1.99 mS/cm, respectively.

The variables were statistically analyzed with random block design, with factorial arrangement 2 x 2 x 3. The factors were two densities, two sowing dates and three morphological fractions of the plant. The statistical software SPSS version 17.0 (SPSS 2008) was used for the statistical analysis and the mean values were compared with the Duncan's test (1955).

Results and Discussion

The sowing date and density influenced ($P < 0.01$) on the yield of the morphological components. The highest leaf production was achieved in the early season, with value of 3.33 t/ha. That of the stem was higher in the late season, with 2.03 t/ha (table 2). After 45 d of regrowth, the total yield (t DM/ha) was of 5.75 for the grassland sown in the early season and of 4.71 in the late one. In both densities, high and low, they were of 4.66 and 6.06 t DM/ha, respectively.

Padilla and Curbelo (2005) found yields of 11.5 t/ha at 90 d of cut and Santana *et al*. (2010) informed values in Napier (*Pennisetum purpureum* Schum.) of 12.22 t/ha at 46 d of regrowth, the double found in this study. These differences may be explained by the conditions of the experiments. The pasture establishment cut influenced on the forage production of this assessment, under semi-arid conditions and without irrigation or fertilization, factors diminishing the forage production (Nava *et al*. 2013).

The lowest production in the late sowing could be due to the climatic conditions, lower temperatures and low light intensity, not allowing the optimum development of the plant. It is important to highlight that this clone survived to the frost that occurred during the experimental period. This aspect had not been reported previously in the literature as this was the first experiment conducted under edaphoclimatic conditions, with extreme temperatures for this type of plant.

There were differences (P < 0.05) in both sowing dates for the ash content of leaves and stems. They had higher values during the early season, with 17.49 and 16.9 %, respectively (table 2). In general, lower values were observed in leaf and stem during the late season.

The results of this study do not agree with those referred by Herrera *et al*. (2008), who reported 9.2 and 3.9 % in leaf and stem, respectively, and its explanation is similar to that stated for the yield. Besides, Herrera and Ramos (2006) stated that the minerals content in plants depend, among other factors, on the amount, shape and availability of minerals on the soil, as well as their solubility in the soil water. There were no differences in the ash due to the density. Values among 17.5 and 17.6 % were presented in high and low density, respectively.

The table 3 shows that the CP percentages in leaves, stems and dead material varied (P < 0.05) with values of 11.3, 10.04 and 6.0 %, respectively. The protein value was higher (P < 0.05) in leaves and stems (11.3 and 10.04 %) compared with that of the dead material (6.0 %). It also varied with the sowing date (P < 0.05) and had values of 10.3 and 8.0 % in the early and late season, respectively (table 4). There was not significant effect of the density, and the values were of 9.0 and 9.3 % for the high and low density, respectively. These results were similar to that informed by Santana *et al*. (2010) in the Pennisetum genre, cultivated in the Cauto Valley, Cuba. This region is characterized by high temperatures and rainfall below 700 mm. However, the CP content in the leaf was lower and higher in the stem than that reported by Valenciaga *et al*. (2001) for this same clone, cultivated in the western part of Cuba, where the rainfall reached values of 1200 mm annually. Rodríguez *et al*. (2009) found CP values of 11.7 %, slightly higher than those informed in this study.

This previously stated shows the importance of genotype environment relation, as it may determine the performance of the pasture chemical composition, expressed by the CP. This aspect should be considered when introducing and assessing a grassland species in different ecosystems.

The CP content in leaf and stem was important, sufficient not to limit the ruminal microbial fermentation and, thus, the pasture ingestion (Minson 1990). Therefore, further studies including the animal are necessary, as well as the aspect related to the pasture management, especially both the organic and mineral fertilization.

Table 3 shows the ADF content with the differences (P < 0.05) obtained in leaves, stems and dead material. The percentage was higher in the dead material (34.3 %), expected when part of the plant dies, mainly the leaf and the cell wall increases due to the water loss. The leaf and stem content had values similar to 33.1 %. There was no effect of the density, which had values of 33.8 and 33.6 %, for the high and low density, respectively. The results agree with the reports of Valenciaga *et al*. (2009), who studied the effect of the regrowth age on the structural carbohydrates of this clone. There was no effect either of the sowing season, with values of 33.9 % in early season and 33.6 % in the late one.

There were significant differences (P < 0.05) between leaves, stems and dead material for the hemicellulose, with values of 28.9, 27.7 and 26.4 %, respectively (table 3). There were also differences for the sowing date (P < 0.05), with values of 27.2 and 28.3 % for the early and late season, respectively (table 4). The

Table 2. Effect of the sowing date on the content of ashes (%) and yield (t MS/ha) in the different morphological components

Sowing date	Morphological components					
	Leaf		Stem		Dead material	
	Ashes	Yield	Ashes	Yield	Ashes	Yield
Early season	17.5	3.33	16.9	1.66	20.5	0.76
Late season	15.5	1.96	14.7	2.03	20.0	0.72
SE ±	0.4*	0.3**	0.4*	0.3**	0.4*	0.27**

*P < 0.05 **P < 0.01

results of this research, referred to the performance of hemicellulose concentration for CUBA CT-115, differed from that referred by Valenciaga *et al*. (2009a). It could be attributed to the differences on the environmental conditions, type of soil, plant age, management and availability of nutrients, among other factors. There were no differences for the sowing season, with values of 27.2 and 28.3 % in the early and late season, respectively.

The determined digestibility value in leaf was 62.8 % and 64.9 % in stem. The values of digestibility in early and late season were 65 and 62.7 %, respectively. The values of high and low density were 64.7 and 63 %, respectively. The general average was 63.6 %, slightly lower than the informed by Valenciaga *et al*. (2009a).

This indicator represents the usage rate of the food offered to the animal. Under the conditions of this research they were encouraging, mainly considering that no mineral fertilization and irrigation were used, and the pasture was submitted to low temperatures during winter. This indicated the necessity of further researches to explain best this performance of the crop in the northeast of Mexico.

Table 3 Content of CP, ADF and hemicellulose in the different morphological components.

Morphological component	Protein, %	ADF, %	Hemicellulose, %
Leaf	11.3[a]	33.1[b]	28.9[a]
Stem	10.0[a]	33.1[b]	27.7[b]
Dead material	6.0[b]	34.3[a]	26.4[c]
SE ±	0.5*	0.3*	0.4*

[a, b]Values with different letters differ at $P < 0.05$ (Duncan 1955)
*P < 0.05

Table 4. Effect of the sowing date on the content of CP and hemicellulose

Sowing date	CP, %	Hemicellulose, %
Early season	10.3	27.2
Late season	8.0	28.3
SE ±	0.44 *	0.34*

*P < 0.05

The cell content varied ($P < 0.05$) in the different morphological components, due to the effect of density and sowing season. The highest values were in the leaves, in the low density and late season (37.9 %) and the early one for the stem, with value of 40.0 % in low density and in dead material (42.0 %).

This indicator is important for the plant as it has all the substances needed for the growth and development of issues and organs. Besides, from the animal nutrition point of view, it has the basic substance that will be part of the animal metabolism. Therefore, considering this indicator for selecting the plants destined for forage production is vital.

Digestibility did not vary in the different morphological components neither with the season nor with the sowing.

There was significant interaction for the NDF among between treatments, and varied ($P < 0.05$) due to the density and sowing season in the different morphological components. The highest value was found in the stem when sowing in high density and in the late season, with value of 64.4 %. The lowest one (58.0 %) was for the stem in the low density during the early season (figure 1). The rest of the values for leaf, stem and dead material

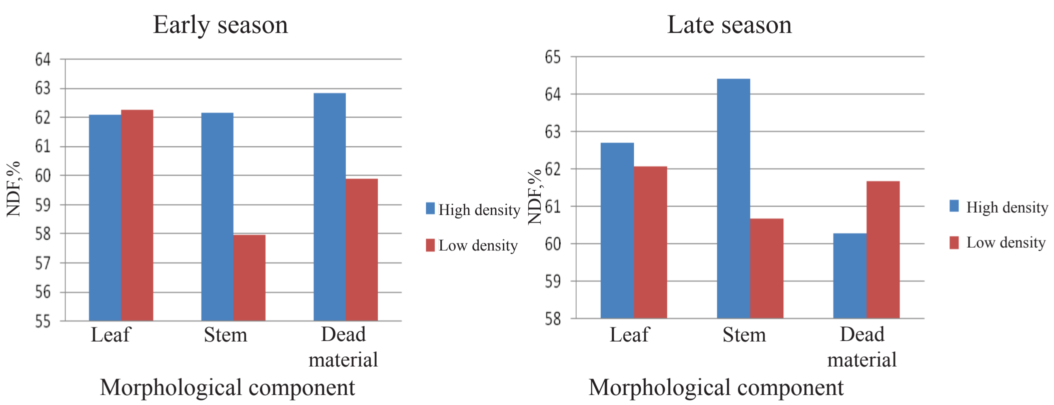

Figure 1. Effect of the density and sowing date on the NDF content from the different morphological components.

were similar (in both densities and sowing seasons, with values between 59.9 and 62.9 %, respectively. The low temperatures (- 6 0C) during the experimental stage diminished the growth and development of the pasture (Herrera *et al*. 2013). Thus, there were fewer amounts of dead material and lower NDF content in this part of the plant for treatment planted in the late season.

The CT-115 (*Pennisetum purpureum*) had good nutritive quality compared with the indicators informed in the traditional pastures used in the region (*Cenchrus ciliares*, *Cynodon dactylon*, *Dichanthium annulatum* and *Panicum coloratum*), so it may be considered a promising alternative for cattle feeding in the northeast of Mexico.

Further researches are recommended to explain the performances informed here. Especially, that related to the tolerance to low temperatures. Starting the tests related to the management of this pasture under semi-arid conditions in the Mexican northeast is also suggested.

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