Morphological variation in *Paspalum nicorae* Parodi accessions, a promising forage

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ABSTRACT: *Paspalum nicorae* Parodi is a perennial, apomictic tetraploid forage species, native in the state of Rio Grande do Sul, Brazil, with grazing tolerance and adapted to sandy soils and moderate droughts. As a first step to future breeding, a morphological characterization regarding leaf hairiness, sheath, leaf and central venation color, growing habit, plant height, raceme number and length, and leaf length and width was performed in 53 accessions from Rio Grande do Sul that are part of a *Paspalum* species breeding program. 35.84% of the accessions had completely hairy leaves, 73.58% had green sheath, 54.71% whitish central venation, 50.94% decumbent habit. Leaf color was estimated by two methods, color chart and colorimeter. The accessions were classified as 76.92% green, 13.45% greenish yellow and 9.62% as grayish green by the first, and 59.62% grayish, 32.69% grayish yellow, 5.77% yellow and 1.92% dark grayish by the second method. Raceme length ranged from 9.40 to 1.30 cm, number of racemes from one to six (48.73% of the accessions had four racemes), leaf length and width from 36.13 to 13.06 cm and 0.67 to 0.36 cm, respectively, and plant height from 115.70 to 29.00 cm. Therefore, a large morphological variation among accessions was detected, with no relation to geographical location but indicating a high potential use in plant breeding programs.
Key words: apomixis, forage grass, morphology, plant breeding

Variação morfológica em acessos de *Paspalum nicorae* Parodi, forrageira promissora

RESUMO: *Paspalum nicorae* Parodi é uma forrageira perene, apomítica, tetraplóide, nativa no Rio Grande do Sul, com tolerância ao pastejo e adaptada a solos arenosos e a secas moderadas. Como passo inicial para o melhoramento, uma caracterização morfológica considerando pilosidade da folha, cor da bainha, da folha e da nervura central, hábito de crescimento, altura da planta, número e comprimento de racemos, comprimento e largura da folha foi realizada em 53 acessos coletados no Rio Grande do Sul, Brasil, que são parte de um programa de melhoramento de espécies de *Paspalum*. Os resultados mostraram que 35,84% dos acessos tinham folhas completamente pilosas, 73,58% tinham bainha verde, 54,71% venação central esbranquiçada e 50,94% hábito decumbente. A cor da folha foi estimada por dois métodos, cartela de cores e colorímetro Os acessos foram classificados como 76,92% verdes, 13,45% amarelo esverdeados e 9,62% como verde acinzentados pelo primeiro, e 59,62% acinzentados, 32,69% amarelo acinzentados, 5,77% amarelos e 1,92% cinza escuros pelo segundo método. O comprimento do racemo variou de 9,40 a 1,30 cm, o número de racemos de um a seis (sendo que 48,73% dos acessos tinham quatro racemos), o comprimento e a largura da folha de 36,13 a 13,06 cm e 0,67 a 0,36 cm, respectivamente e a altura da planta de 115,70 a 29,00 cm. Portanto, grande variação morfológica foi detectada entre os acessos, sem relação com localização geográfica, mas indicando alta potencialidade de utilização em programas de melhoramento.
Palavras-chave: apomixia, gramínea forrageira, morfologia, melhoramento

Introduction

Many of the 400 species of genus *Paspalum* L., most of them native to tropical and sub-tropical Americas (Moraes-Fernandes et al., 1968) are important forages, as the well studied *P. notatum* Flügge (Pedreira and Pedreira, 2006), due to quality, productivity and tolerance to environmental stresses (Valls, 2000). About 75% of the described *Paspalum* species occur in Brazil, in a wide range of ecological conditions as part of several plant communities (Barreto, 1974). Apomixis and sexual reproduction, both occurring in this genus, are generally related to the polyploid and diploid levels, respectively (Quarín and Norrmann, 1990). *Paspalum nicorae* Parodi ("grama cinzenta", brunswickgrass), of the Plicatula group, is a perennial species, highly tolerant to grazing (Barreto, 1974), tetraploid with 2n = 4x = 40 chromosomes (Burson and Bennett, 1970; Moraes-Fernandes et al., 1974; Pagliarini et al., 2001; Reis et al., 2008) and has a pseudogamous apomictic mode of reproduction

(Burson and Bennet 1970). The importance of *P. nicorae* is due not only to its good quality and forage yield potential but also because it has a high potential to be used for the recovery and conservation of degraded soil, as mentioned by several authors (Burson and Bennett, 1970; Prestes et al., 1976; Pizzarro, 2000; Boldrini, 2006; Dall'Agnol et al., 2006). In Rio Grande do Sul, *P. nicorae* is generally found in sandy soils, indicating a potential to tolerate drought and low-fertility soils, and has a high response to fertilization (Nabinger and Dall´Agnol, 2008) and in such areas it could be a promising forage. However, detailed morphological and agronomic evaluations of a high number of accessions are needed to assess the real potential of the species.

The objective of this study was to investigate morphological variation for several characteristics in a collection of 53 *P. nicorae* accessions that are part of a breeding project including several *Paspalum* species. This same collection has been cytogenetically analyzed by Reis et al. (2008).

Material and Methods

The 53 original individual plants were collected in 17 sites in Rio Grande do Sul, Southern Brazil (Table 1). Plants with different characteristics were chosen by the collectors in each site in order to collect a representative sample of the local existing variability. Plants were transferred to pots filled with soil and kept as part of a germplasm collection. The accessions (each of the 53 plants represents an accession) are identified in the collection by the species' name, the collector´s number and collection site (Table 1) and numbered for working purposes. Later, as the original plants were well grown, they were vegetatively replicated. After the plants had flowered, their taxonomic status was confirmed. All the accessions are tetraploid (2n = 40 chromosomes) as determined by Reis et al. (2008).

The following morphological characters were analyzed: leaf hairiness (HAI), leaf color (CCLCOL by the color chart and COLLCOL by the colorimeter methods, as explained below) sheath color (SCOL), central venation color (CVCOL), growing habit (HAB), plant height (PHEI), raceme number (RNUM), raceme length (RLEN), and leaf length (LLEN) and leaf width (LWID). For four of the characteristics not all of the 53 accessions were examined: RNUM (39 accessions), CCLCOL and COLLCOL (52 accessions each), LLEN and LWID (50 accessions).

For leaf length (LLEN) and leaf width (LWID) evaluation, marked tillers were used. For each accession three tillers (representing the replications) were marked and all the completely expanded leaves were measured weekly for nine weeks (from March 3rd to April 27th, 2007). Leaf hairiness (HAI), was estimated on the upper side of the leaf blade, on a 1 to 5 scale: 1 (no hairs); 2 (25% of the blade with hairs); 3 (50%); 4 (75%) and 5 (100%). Leaf color by the color chart method (CCLCOL) was determined using three color groups of the R.S.H Color Chart of the Royal Horticultural Society of London: green group (chart sub-groups 1 to 5), yellow green group (chart sub-groups 6 to 8) and grayish green group (chart sub-groups 9 to 10). Leaf color by the colorimeter method (COLLCOL) was determined with a MINOLTA CR-300 colorimeter (Konika Minolta, USA) and using the CIE (Comission International de l´Éclairage) L*a*b System: the values were divided in four groups, 1- dark grayish (values 1 -10), 2- light grayish (11-20), 3- grayish yellow (21-30) and 4- yellowish (31-40). Sheath color (SCOL) and central venation color (CVCOL) were estimated visually, and considered to be green (1) or violet (2) and whitish (1) or greenish (2), respectively. Growing habit (HAB) was classified as erect (1) or decumbent (2). Raceme number (RNUM) and length (RELN) were determined during the peak of flowering in totally expanded inflorescences. Plant height (PHEI) was determined by measuring the plant from the soil to the highest leaf, once a week, from February 8th to April 27th, 2007, after a preliminary cut (January 25th, 2007) to standardize initial height. Leaf length and width (LLEN and LWID) were determined at the end of the evaluation period, by measuring all the leaves of each of the three tillers per accession.

Data were analyzed by a descriptive statistics (such as averages, standard deviations etc.).

Results and Discussion

The present work is the first one to present a detailed analysis of morphological variation for several qualitative and quantitative characteristics of a large number of *P. nicorae* accessions (Tables 2, 3, 4 and 5). Regarding leaf hairiness, 16.98% of the accessions had completely glabrous leaves and 35.84% completely hairy leaves (Table 2). Therefore, most of the *P. nicorae* accessions examined were hairy. Barreto (1974) described the species as having hairy or glabrous leaves and Burkart (1969) refers to lightly hairy to subglabrous leaves, seldom very hairy. Boldrini et al. (2005) also mentioned glabrous and hairy biotypes. The present work is the first one to describe variation in degrees of leaf hairiness.

Most of the accessions, 76.92%, were classified as green, 13.45% as greenish yellow and 9.62% as grayish green by the color chart. The colorimeter method distinguished four groups: 59.62% of the accessions were light grayish, 32.69% grayish yellow, 5.77% yellowish and 1.92% dark grayish (Table 2). Boldrini et al. (2005) refer to *P. nicorae* biotypes with greenish or grayish leaves. The colorimetry method has been efficiently used to characterize, for example, post-harvest fruits (Callegaro et al., 2002) and soil color (Botelho et al., 2006). However, the color chart method is more practical to examine plants directly at the field and does not demand laboratory procedures. Most of the accessions, 73.58%, had green and 26.41% violet leaf-sheaths (Table 2). Barreto (1974) reported green and violet leaf sheaths in *Paspalum* species of the Plicatula group, but did not use this character when describing *P. nicorae.* Color of

Table 1 - List of the 53 accessions of *P. nicorae* analyzed.

Accession	Collector[a]	Collection site	Geographical coordinates
2	MD, CN s/n	Cristal	Lat -31°00'00''; Long -52°03'00''
2A	MD, CN s/n		
3	MD, CN s/n	São Lourenço	Lat -31°21'55''; Long -51°58'42''
4	MD, CN s/n	Capão do Leão	Lat -31°45'46''; Long -52°29'02''
4A	MD, CN s/n		
5	MD, CN s/n		
6A	MD, CN s/n	Pinheiro Machado	Lat -31°34'40''; Long -53°22'51''
6B	MD, CN s/n		
8A	MD, CN s/n		
8B	MD, CN s/n		
9	MD, CN s/n	Pinheiro Machado/Candiota	Lat -31°33'28''; Long -53°40'22''
9A	MD, CN s/n		
10	MD, CN s/n	Hulha Negra/Candiota	Lat -31°24'14''; Long -53°52'08''
11A	MD, CN s/n	Bagé	Lat -31°19'51''; Long -54°06'25''
11B	MD, CN s/n		
12A	MD, CN s/n	Dom Pedrito	Lat -30°58'59''; Long -54°40'22''
12B	MD, CN s/n		
13A	MD, CN s/n		
13B	MD, CN s/n		
14	MD, CN s/n	Dom Pedrito/Santana do Livramento	Lat -30°53'27''; Long -55°31'58''
14A	MD, CN s/n		
17	MD, CN s/n	Santana do Livramento	Lat -30°53'27''; Long -55°31'58''
18	MD, CN s/n		
19	MD, CN s/n		
20B	MD, CN s/n		
20C	MD, CN s/n		
26A	MD, CN s/n	Alegrete	Lat -29°47'02''; Long -55°47'28''
26C	MD, CN s/n		
26D	MD, CN s/n		
26F	MD, CN s/n		
27A	MD, CN s/n		
27B	MD, CN s/n		
28A	MD, CN s/n	Rosário do Sul	Lat -30°15'28''; Long -54°54'50''
28B	MD, CN s/n		
28C	MD, CN s/n		
28D	MD, CN s/n		
28E	MD, CN s/n		
29	MD, CN s/n		
30A	MD, CN s/n	São Gabriel	Lat -30°20'09''; Long -54°19'12''
30B	MD, CN s/n		
31A	MD, CN s/n		
31B	MD, CN s/n		
32A	MD, CN s/n	Santa Margarida do Sul	Lat -30°20'09''; Long -54°19'12''
32B	MD, CN s/n		
32C	MD, CN s/n		
33A	MD, CN s/n	Vila Nova do Sul	Lat -30°20'24''; Long -54°04'48''
33B	MD, CN s/n		
34	MD, CN s/n		
35	MD, CN s/n	Eldorado do Sul	Lat -30°05'02''; Long -51°36'57''
36	MD, CN s/n		
37A	DN s/n	Viamão	Lat -30°04'51''; Long -51°01'22''
37C	DN s/n		
37D	DN s/n		

[a]MD–Miguel Dall'Agnol; CN–Carlos Nabinger; DN–Danilo Menezes Sant'Anna; s/n- not numbered.

Table 2 - Morphological data in the 53 *P. nicorae* accessions studied.

Accession	HAI	SCOL	CVCOL	HAB	CCLCOL	COLLCOL	RNUM	RLEN	PHEI	LLEN	LWID
								cm[a]			
2	2	1	2	1	1	3	4	3.70	22.77	13.06	0.43
2A	4	1	1	1	1	3	-	-	45.14	25.35	0.50
3	1	1	1	1	1	2	4	2.75	40.58	22.36	0.49
4	5	2	1	1	1	2	4	3.53	57.57	34.23	0.57
4A	4	1	1	2	1	3	4	3.38	44.04	28.79	0.58
5	1	2	1	2	3	1	3	2.60	49.63	28.04	0.39
6A	1	1	2	2	1	2	4	3.38	50.91	28.11	0.46
6B	5	2	2	2	1	2	5	2.98	53.57	24.99	0.51
8A	2	1	1	1	3	2	-	-	47.89	23.42	0.44
8B	2	1	2	1	3	2	-	-	45.51	22.19	0.36
9	3	2	1	1	1	3	4	3.15	51.01	28.47	0.62
9A	3	1	1	2	1	2	4	3.50	58.11	34.08	0.47
10	1	1	1	1	3	2	4	2.73	52.93	28.46	0.50
11A	5	1	2	2	2	4	3	3.67	54.55	32.89	0.58
11B	4	1	1	2	1	3	4	4.68	47.62	28.18	0.62
12A	5	2	1	2	1	2	4	6.98	77.20	35.38	0.67
12B	5	1	1	1	1	2	4	6.28	76.38	35.92	0.63
13A	5	1	2	1	1	2	6	3.20	53.80	26.52	0.54
13B	5	1	1	2	1	2	5	3.50	48.77	27.30	0.50
14	2	1	2	2	1	2	4	4.93	38.63	20.93	0.36
14A	5	1	2	2	1	2	-	-	45.67	21.57	0.37
17	1	1	2	2	3	2	2	2.35	43.83	27.85	0.54
18	1	2	2	2	3	2	3	3.17	43.00	23.90	0.49
19	2	1	1	1	1	3	-	-	78.83	28.33	0.61
20B	3	2	1	1	1	3	6	3.28	56.11	31.07	0.54
20C	5	1	1	1	2	2	-	-	43.32	25.19	0.60
26A	1	1	1	2	2	2	-	-	56.5	28.41	0.43
26C	2	1	1	1	1	3	5	3.26	40.07	26.01	0.38
26D	5	1	1	2	1	3	3	4.13	75.11	36.27	0.56
26F	5	1	1	2	1	2	4	3.63	51.32	26.03	0.47
27A	5	2	2	2	-	-	2	3.05	39.02	20.21	0.37
27B	5	1	2	2	1	3	3	3.83	43.59	25.97	0.45
28A	3	1	1	1	1	2	3	2.23	54.14	23.46	0.45
28B	3	2	1	1	1	2	4	3.43	65.18	29.21	0.48
28C	3	2	2	1	1	2	-	-	69.28	36.13	0.56
28D	5	1	1	1	1	3	3	4.17	59.74	29.21	0.40
28E	2	1	1	1	2	2	3	5.03	69.42	34.59	0.47
29	3	1	2	2	2	4	4	3.90	43.20	24.16	0.50
30A	5	1	1	2	1	2	4	3.73	54.80	32.28	0.60
30B	5	1	2	1	1	3	-	-	39.79	29.57	0.55
31A	5	1	2	1	1	2	-	-	37.66	24.57	0.53
31B	2	1	2	1	2	3	4	3.68	48.89	23.35	0.44
32A	3	1	2	1	2	4	4	3.98	41.22	21.24	0.49
32B	3	1	2	1	1	3	5	2.92	51.41	23.75	0.50
32C	3	1	2	1	2	2	4	2.00	46.36	28.99	0.50
33A	5	2	2	2	1	2	5	3.24	45.43	-	-
33B	4	2	2	1	1	3	-	-	9.55	-	-
34	5	1	2	2	1	3	-	-	34.78	22.12	0.67
35	2	1	2	1	1	2	5	3.16	27.77	14.65	0.43
36	4	1	1	2	1	3	-	-	50.69	28.69	0.48
37A	1	1	1	2	1	2	-	-	49.29	-	-
37C	1	2	1	2	1	2	3	1.98	59.22	27.88	0.48
37D	2	2	1	2	1	2	3	3.54	68.88	30.81	0.46

[a]Average values (see Material and Methods). HAI: leaf hairiness – 1 (absent); 2 (25%); 3 (50%); 4 (75%); 5 (100%). SCOL: sheath color – 1 (green); 2 (violet). CVCOL: central venation color – 1 (whitish); 2 (greenish). HAB: growing habit – 1 (erect); 2 (decumbent). CCLCOL: leaf color by color chart – 1 (green group); 2 (yellow green group); 3 (grayish green group). COLLCOL: leaf color by colorimeter - 1 (dark grayish); 2 (light grayish); 3 (grayish yellow); 4 (yellowish). RNUM: raceme number. RLEN: raceme length. LLEN: leaf length. LWID: leaf width.

Table 3 - Descriptive statistics for the seven quantitative characteristics analyzed in *P. Nicorae*.

Variable	Variance	Average	Maximum	Minimum	Standard deviation	Number of observations
HAI	2.3606	3.2830	5	1	1.5364	53
SCOL	0.1981	1.2641	2	1	0.4450	53
CVCOL	0.2525	1.4528	2	1	0.5025	53
HAB	0.2547	1.5094	2	1	0.5046	53
RNUM	0.8313	3.8974	6	2	0.9117	39
CCLCOL	6.8759	3.7884	10	1	2.6222	52
COLLCOL	0.405732	2.42308	4	1	0.6369	52

HAI: leaf hairiness – 1 (absent); 2 (25%); 3 (50%); 4 (75%); 5 (100%). SCOL: sheath color – 1 (green); 2 (violet). CVCOL: central venation color – 1 (whitish); 2 (greenish). HAB: growing habit – 1 (erect); 2 (decumbent). RNUM: raceme number. CCLCOL: leaf color by color chart – 1-5 (green group); 6-8 (yellow green group); 9-10 (grayish green group). COLLCOL: leaf color by colorimeter - 1 (dark grayish); 2 (light grayish); 3 (grayish yellow); 4 (yellowish).

the central venation was whitish in 54.71% and greenish in 45.29% of the accessions (Table 2).

Regarding growing habit, 50.94% of the accessions had a decumbent while 49.06% had an erect habit (Table 2). Raceme number and length varied greatly among the accessions analyzed. Number of racemes ranged from two to six: 48.72% of the accessions had four, 25.64% three, 15.38% five, 5.13% two and 5.13% six racemes (Table 2). Burkart (1969), Barreto (1974) and Boldrini et al. (2005) described *P. nicorae* as having from two to five racemes. This is also the first report of six racemes (in two out of 53 of the accessions examined) in the species. Raceme length (average values) ranged from 1.98 to 6.98 cm (Table 2). Barreto (1974) reported racemes from two to five cm in *P. nicorae*, while Burkart (1969) referred to 1.5 to 6.5 cm.

Plant height (average values) among accessions ranged from 22.77 to 77.20 cm (Tables 2 and 4), agreeing with Burkart (1969) who described plants ranging from 20 to 70 cm high. Average leaf length and width among accessions ranged from 13.06 to 36.27 cm and from 0.36 to 0.67 cm, respectively (Tables 2 and 5). Burkart (1969) reported leaf width in *P. nicorae* as ranging from 0.4 to 0.5 cm. Leaf length and width divided the accessions basically in three groups: one (50.00% of the accessions) with long (more than 20 cm) and wide (more than 0.5 cm) leaves, the second (46.15% of the accessions) with long (more than 20 cm) and narrow (smaller than 0.5 cm) leaves and the third (3.85% of the accessions, representing two accessions), with small (less than 20 cm) and narrow (smaller than 0.5 cm) leaves.

No relations between a specific geographical location and a given characteristic was verified, for the quantitative as well as for the qualitative characteristics (Tables 1 and 2). For example, the different leaf colors and growing habits were found in accessions spread all over the collection area; on the other hand, two accessions (11 A and 11B) collected in the same locality had different leaf colors by both the color chart and the colorimeter methods and other two, also collected at the same place (12A and 12B) had a decumbent (12A) and an erect (12B) habit. Plants belonging to the three groups of leaf length-width were also found all over the collection area.

That variation exists in apomictic species and is well known and reported for several species (Asker and Jerling, 1982). For example, in a germplasm collection of *Paspalum notatum,* in which morphological, agronomical and molecular variation among different accessions have been reported, Dahmer et al. (2008) found great variability in meiotic configurations among the apomictic tetraploid accessions. Reis et al. (2008), working with the same 53 accessions of *P. nicorae* examined here, observed that, despite the absence of variability in chromosome numbers, the frequencies of different chromosome associations varied among accessions.

The high variation found among accessions, as well as the fact that accessions of the same collection site differed in some characteristics, can be explained by adaptation to the local where plants grow but also by the apomictic mode of reproduction of *P. nicorae*. As apomictic species do not depend on sexual reproduction for survival, any new neutral variation (in the sense that it does not hinder the plant survival or adaptation), that has appeared by mutation or by rare recombination events during the evolutionary history of the population may be maintained. Therefore, plants with different phenotypes may propagate by the apomictic seeds or by vegetative propagation (or even by residual sexuality when it does exist), forming a pool of different clones in a given area (Asker and Jerling, 1982). Many of the characteristics analyzed for *P. nicorae,* as leaf color, sheath and central venation color, among others, are most probably not related to plant adaptation, which could explain the high variation not only among accessions but also between accessions of the same collection site. Furthermore, the existence of sexual types, not yet found for *P. nicorae* but already reported in other *Paspalum* species (Quarín and Normann, 1990), would allow the continuous formation of new apomictic types through hybridization with true apomictics.

Finally, as a following to the present work, the value of these accessions as forage plants has to be tested in other studies, under field conditions.

Table 4 - Descriptive statistics for the qualitative characteristic PHEI - plant height (cm) analyzed in *P. nicorae*.

Accession	Average	Standard deviation	Maximum	Minimum	Variance
2	22.7667	5.281	29.00	10.00	27.8900
2A	45.1444	7.809	51.40	29.20	60.9878
3	40.5778	3.800	47.70	36.00	14.4419
4	57.5667	4.715	63.20	46.80	22.2325
4A	44.0444	8.352	56.40	31.00	69.7503
6A	50.9111	2.723	53.80	47.70	7.4161
6B	53.5567	10.978	62.50	31.00	120.5200
8A	47.8889	3.409	51.00	39.50	11.6211
8B	45.511	6.783	56.00	37.50	46.0110
9	51.0111	9.119	59.80	30.00	83.1486
9A	58.1111	7.384	67.10	44.70	54.5261
10	52.9333	8.202	63.30	41.90	67.2775
11A	54.5556	9.485	64.00	40.00	89.9703
11B	47.6222	12.515	62.30	30.00	156.6169
12A	77.2000	8.821	89.20	64.50	77.8150
12B	76.3778	6.390	87.00	67.00	40.8369
13A	53.8000	7.651	63.60	40.20	58.5375
13B	48.7667	9.612	58.70	28.80	92.3950
14	38.6333	3.063	42.00	34.50	9.3850
14A	45.6667	8.894	57.80	34.00	79.1100
17	43.8333	4.945	50.20	35.50	24.4550
18	43.0000	6.061	49.00	28.50	36.7350
19	78.8333	16.874	11.70	54.00	284.7400
20B	56.111	3.959	60.00	47.00	15.6711
20C	43.3222	5.702	50.50	34.50	32.5094
26A	56.5000	8.685	72.60	47.00	75.4225
26C	40.0667	4.444	47.50	32.00	19.7525
26D	75.1111	11.867	85.50	50.00	140.8211
26F	51.3222	5.309	58.70	41.70	28.1819
27A	39.0222	2.488	42.00	35.20	6.1894
27B	43.5889	5.968	50.50	34.50	36.6211
28A	54.1444	3.574	60.60	51.00	12.7703
28B	65.1778	3.339	69.50	57.50	11.1519
28C	69.2778	3.585	74.50	65.20	12.8544
28D	59.7444	6.335	67.40	49.50	40.1378
28E	69.4222	6.249	79.00	50.50	39.0544
29	43.2000	11.492	52.00	21.00	132.0600
30A	54.8000	6.317	62.00	46.50	39.9100
30B	39.7889	6.643	53.50	32.50	44.1286
31A	37.6556	5.963	49.30	30.50	35.5528
31B	48.8889	7.875	58.70	37.50	62.0136
32A	41.2222	7.082	48.20	29.50	50.1519
32B	51.4111	6.331	58.10	40.50	40.0861
32C	46.3556	12.600	62.30	31.00	158.7603
33A	45.4333	2.363	48.20	42.00	5.5825
33B	9.5556	16.576	42.00	1.00	273.7778
34	34.7778	13.236	42.30	1.00	175.1944
35	27.7667	9.301	41.10	10.00	86.5150
36	50.6889	5.599	59.10	44.30	31.3461
37A	49.2889	7.267	61.40	39.50	52.8136
37C	59.2222	4.734	69.20	51.40	22.4144
37D	68.8778	8.285	79.70	56.50	68.6494
General average	50.1830				

Table 5 - Descriptive statistics for the qualitative characteristics LLEN- leaf length (cm) and LWID- leaf width (cm) analyzed in *P. nicorae*.

Accession	LLEN		LWID		Groups[a]
	Average	Standard deviation	Average	Standard deviation	
2	13.0625	4.2592	0.4344	0.1044	3
2A	25.3500	9.2433	0.5021	0.1344	1
3	22.3682	9.1689	0.4941	0.1159	2
4	34.2350	11.2898	0.5650	0.0587	1
4A	28.7900	10.8254	0.5760	0.1033	1
5	28.0478	6.9124	0.3913	0.0417	2
6A	28.1143	10.4293	0.4633	0.0896	2
6B	24.9944	10.4456	0.5111	0.1008	1
8A	23.4250	11.5406	0.4417	0.0776	2
8B	22.1917	8.9906	0.3613	0.0600	2
9	28.4667	11.7201	0.6214	0.0902	1
9A	34.0762	10.4466	0.4748	0.0999	2
10	28.4609	10.2574	0.5000	0.0889	1
11A	32.8957	10.6601	0.5783	0.0850	1
11B	28.1833	7.8135	0.6222	0.0808	1
12A	35.3783	14.6889	0.6661	0.1398	1
12B	35.9208	11.0952	0.6292	0.0806	1
13A	26.5217	9.1528	0.5391	0.0783	1
13B	27.3000	9.0990	0.4955	0.0999	2
14	20.9267	9.9136	0.3600	0.0632	2
14A	21.5714	8.6756	0.3693	0.0783	2
17	27.8478	7.0653	0.5413	0.0577	1
18	23.9000	9.6335	0.4870	0.0626	2
19	28.3296	10.9558	0.6148	0.0818	1
20B	31.0739	7.5965	0.5413	0.0577	1
20C	25.1957	9.2135	0.6000	0.0798	1
26A	28.4091	13.7346	0.4341	0.1357	2
26C	26.0150	7.6288	0.3800	0.0768	2
26D	36.2682	14.2699	0.5614	0.1154	1
26F	26.0273	12.8726	0.4682	0.0933	2
27A	20.2154	5.8609	0.3725	0.1017	2
27B	25.9682	6.7062	0.4500	0.0617	2
28A	23.4636	6.9416	0.4555	0.0875	2
28B	29.2103	10.7882	0.4845	0.2000	2
28C	36.1333	8.4549	0.5604	0.0872	1
28D	29.2091	8.0933	0.4032	0.0752	2
28E	34.5958	13.2368	0.4750	0.0608	2
29	24.1579	11.7887	0.4968	0.1279	2
30A	32.2840	11.2091	0.5980	0.1005	1
30B	29.5700	10.9538	0.5500	0.1179	1
31A	24.5722	4.7128	0.5300	0.1261	1
31B	23.3550	8.6878	0.4450	0.0605	2
32A	21.2421	6.5709	0.4947	0.0848	2
32B	23.7500	7.9316	0.5050	0.0999	1
32C	28.9875	10.7668	0.5013	0.0981	1
34	22.1231	8.5608	0.6731	0.1194	1
35	14.6556	5.8520	0.4333	0.1283	3
36	28.6917	8.0031	0.5008	0.0770	1
37C	27.8765	11.6050	0.4800	0.0752	2
37D	30.8077	7.0276	0.4592	0.0511	2
General average	26.9139		0.5302		

[a]Groups 1- long (more than 20 cm) and wide (more than 0.5 cm) leaves; 2- long (more than 20 cm) and narrow (smaller than 0.5 cm) leaves; 3- and the small (less than 20 cm) and narrow (smaller than 0.5 cm) leaves.

Conclusions

There is a high morphological variation for all characteristics analyzed among the *P. nicorae* accessions studied, but is not related to their geographical location.

This richness of variation represents an extremely valuable source to select better accessions to be used as forage plants.

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